Nutrition, Health, and Human Capital Development: Evidence from South Korea, 1946–1977

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Abstract

Using newly collected archival data, this study investigated how nutritional availability in two crucial periods for human growth, namely, early childhood and adolescence, affected the heights of South Korean conscripts born from 1946–1957. Results strongly suggest nutrition was an important determining factor of biological standards of living indicated by adult height. Provisions of calories and protein were associated strongly with larger stature. Food availability during early childhood was more critical for human growth than nutrition in adolescence. Nutrition in growing ages also had a strong effect on educational attainment. Increased nutritional supply in adolescence mitigated the negative consequences of early-life exposure to the Korean War. Improved nutrition in early childhood and adolescence accounted for 30% to 50% of the increase in adult height (about 2 cm) that was gained between the 1951 and 1957 birth cohorts. Increased nutritional availability during early childhood explains the majority of the contribution.

Keywords: nutritional availability; early childhood; adolescence; height; education
JEL Classifications: I15, I31, N35, N55

1. Introduction

South Korea has achieved rapid economic growth since its liberation from the Japanese occupation in 1945. Within a mere four decades after the Korean War (1950–1953), South Korea has emerged as one of the richest newly industrialized countries. Previous estimates of incomes have suggested that the real GDP per capita stagnated in the early 1960s and began to increase rapidly in the following years (Pyo, 2001; Kim, 2012; Cha, 2014). World Bank Statistics indicated that the annual growth rate for per capita GNP in South Korea was 6.6 percent in 1965–1999, the highest among all countries (Song, 2003).

In general, the rapid economic growth in South Korea during the second half of the 20th century has immensely improved the standards of living of the country's population. At present, South Koreans enjoy considerably higher levels of material well-being than those with from six or seven decades ago. Current per capita income in dollar value is more than 400 times higher than that in 1953.[2] At present, life expectancy at birth is 30 years longer than that in 1960.[3]

However, the period when the standards of living have begun to flourish is unclear. Available evidence pertaining to several measures of human well-being suggests that improvements have been proceeding since the 1960s. Although vital statistics prior to 1970 are highly unreliable, life expectancy appears to have substantially increased between 1960 and 1970 (National Statistical Office, 1998). Substantial fluctuations were noted in the rates of morbidity and mortality caused by acute infectious disease from 1946 to 1954, although a long-term declining trend has emerged if not for the short-term decrease and increase in 1948 and increase in 1951 (Lee 2016). Age at menarche is often used as an index of the biological standard of living. Several studies determined that menarcheal age declined, particularly after 1946 (Hong et al., 1993; Hwang et al., 2003; Sohn, 2016).

Despite this general consensus on the long-term trend in the standards of living, the manner by which the living conditions in South Korea have changed over time and the major factors that produced the changes remain unexplored. For example, substantial knowledge should still be obtained on how the process of improvements differed by socioeconomic characteristics and how the experiences of each birth cohort differed with each other. Moreover, we have yet to completely understand how particular economic or social changes have affected the well-being of the population.

Rigorous research on these issues is often considerably hampered by shortage of the

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[2] The per capita GNP in 1953 is estimated at 67 dollars (Song 2003, p. 106); per capita income in 2016 is 28,524 dollars.

[3] Life expectancy in 1960 was 52 years (National Statistical Office 1998: 54) but increased to 82 years by 2016.

appropriate data, particularly for the periods prior to the 1970s. We can obtain reasonably large and representative micro data on household incomes and consumption expenditures only after the 1970s. Many of the previous studies that utilized the biological measures of standards of living were based on recent survey data, including aging birth cohorts, which are subject to a few shortcomings, such as selective survival of healthy individuals and shrinkage of heights at old age. Other similar studies in the past relied on relatively small samples of particular demographic groups, thereby resulting in difficulty to generalize the results for the entire population. Furthermore, the vast majority of the sources used by these studies restrict us from inferring the socioeconomic backgrounds and ecological environments of individuals in growing ages.

In the present study, we attempt to overcome the limitations of the current data on the standards of living in South Korea prior to the 1970s by analyzing new data on South Korean military records that were collected from the Military Manpower Administration. We also constructed province- and county-level data on local nutritional availability, and matched them with the sample of the conscripts using the information on the place of residence. Using these data, this paper investigates how nutritional availability in two crucial periods of human growth, namely, early childhood (from conception to age 3) and adolescence (from age 12–16), has affected the heights of South Korean conscripts born from 1946 to 1957. We also explore the extent by which the observed increase in adult heights across birth cohorts can be accounted for by improved nutrition during infancy and adolescence.

We focus on height for the following reasons. First, height is a primary index of cumulative net nutritional status during the growing ages. Adult height is also known as a strong predictor of health and mortality. Therefore, establishing primary determinants of adult height will facilitate the understanding of how and why the standards of living in South Korea have changed over time. Second, the mean adult height slightly declined for the cohorts born prior to1951, presumably due to the adverse effects of early-life exposure to the Korean War (Lee 2014, 2017a), and increased rapidly thereafter between the 1951 and 1957 birth cohorts. For these birth cohorts, no clear secular trends in weight were observed. A productive method to understand the causes of long-term changes in standards of living is to focus on heights with changes that reveal secular trends for the cohorts under investigation.

A few studies provided evidence regarding the long-term trends and socioeconomic differences in heights of South Koreans born prior to the 1960s. Several studies compared across different birth cohorts (Hong et al., 1993; Hwang et al., 2003; Schwekendiek and Jun, 2010; Pak et al., 2011; Sohn, 2016), while others focused on the changes in age-specific anthropometric measures across different years (Lim et al., 1986; National Statistics Office, 1998; Pak, 2004; Lee and Park, 2005; Kim et al., 2006; Kim et al., 2008; Choi and Kim, 2012; Korean Agency for Technology and Standards, 2015). Compared with the relatively active research on height changes during the Japanese colonial era (Choi and Schwekendiek, 2009; Kim and Park, 201), the trends and determinants of heights of individuals born between 1945 and 1960 are less clearly understood.

The studies on cohort-specific stature generally show that the heights of South Koreans increased from the cohorts born after 1945, with substantial differences across birth cohorts and across demographic characteristics observed. Hwang et al. (2003) determined that height increase was slower for the 1940–1959 birth cohorts and the 1960–1969 birth cohorts based on a small sample of females included in the Ansan Health Study. Sohn (2016) also maintained that the trend of male heights was rather flat for the cohorts who experienced the Korean War and its aftermath in childhood. Hong et al. (1993) suggested that the population size of the place of residence was positively related to the heights of girls of menarcheal age.

Differences in height increase by gender and age group have been determined by the studies based on age- and year-specific measures. Between 1965 and 1975, the largest height change was determined at age 7 for boys and girls (Kim et al., 2008; Choi and Kim, 2012). The increase in average height of infants and younger children occurred visibly in 1966–1984, which was a period of rapid economic development in South Korea (Kim et al., 2008; Choi and Kim, 2012). Kim et al. (2008) reported that the heights in all age group between 12 and 24 stagnated between 1945 and 1950s but rapidly increased thereafter. Lee and Park (2005) determined that the stature of children aged 6 to 11 stagnated or declined between 1953 and 1966.

The current study is distinct from previous studies on South Korean stature in several aspects. First, this study is the first attempt to investigate the determinants of adult stature based on a large and representative sample of the birth cohorts born between 1945 and 1960. The birth cohorts born immediately after the Second World War spent their childhood and adolescence during periods of upheavals, including chaotic political and social circumstances that followed the liberation from the Japanese occupation, the Korean War that devastated the entire country, and the long and slow recovery from the destruction caused by the two wars. By contrast, the birth cohorts born toward the end of the 1950s were the first generation to benefit from spending childhood during periods of prolonged peace and rapid economic growth in the 1960s and 1970s. Thus, comparisons of these birth cohorts offer an opportunity to understand how the radical social and economic changes during the three decades after 1945 have affected the standards of living of South Koreans.

Second, the current study is the first to explore how local nutritional availability and other family and environmental characteristics in growth periods have affected the heights of South Korean adults. Similar previous studies were only able to consider the differences in heights across birth cohorts and across regions (Choi and Schwekendiek, 2009; Kim and Park, 2011). The present study is unique because it analyzes the effects of parental characteristics, which are a key determining factor of living conditions in growth periods. Obtaining data that simultaneously provide information on adult heights of individuals and their parental characteristics is difficult. In addition, we developed and utilized more detailed measures of local nutritional availability than those used in previous studies on nutrition and heights (Haines et al., 2003). We used four different indices of nutritional availability, namely, total calories and three major nutrients measured in two different crucial periods of human growth (i.e., infancy and adolescence). The improved quality of variables enables us to address several issues that have not been completely understood. For example, we can use our data to analyze which nutrient is considerably important for the growth of South Koreans and how nutritional availability in infancy and adolescence affects adult heights differently.

The rest of this paper is organized as follows. Section 2 introduces two major data sets, namely, sample of South Korean Military Records with over 18,000 conscripts and province- and county-level data on agricultural productions from 1950 to 1980, which we used as bases for our analyses. Section 3 explains how we created the variables for local nutritional availability in early childhood and adolescence and other explanatory variables included in the regression analyses for adult heights. This section also explains how various samples used in our analyses are selected. Section 4 provides the regression results that present how nutritional availability in growth periods affected the heights of South Korean adults. Section 5 explores how nutritional availability affected educational attainment and if increased nutrition in adolescence mitigated the negative effects of early-life exposure to the Korean War. Moreover, this section presents the result of an exercise that show how improved nutrition has substantially contributed to the increase in heights. The concluding section summarizes the results and their implications.

2. Data

2.1. Sample of Korean Military Records[4]

After a large-scale recruitment was attempted on a compulsory basis following the outbreak of the Korean War, military service is currently a mandatory duty for all males in South Korea. All males have to take physical examinations for military conscription at age 20. Military record cards are produced for all males, including those who are exempt from service. On the front page of the card, the details on personal and family characteristics and the results of physical examinations are recorded. For veterans, military service records are provided on the back page of the card.

[4] See Lee (2016) for more detailed methods of collections and descriptive statistics of the data.

The carded military records (CMR) are kept in the central office of the Military Manpower Administration (MMA). Since 2002 (for the birth cohorts born in 1982 or later), CMRs are available in machine-readable forms. For earlier birth cohorts, either image files or micro films of military records can be obtained. From the total number of records, CMRs may be available for the entire male population at least from the mid-1960s. Figure 2.1 shows a sample of CMR.

<Figure 2.1>

By obtaining permission from MMA, we collected a 0.5% sample of CMRs for the birth cohorts born from 1946 to 1957. CMRs for the individuals born between 1948 and 1957 are contained in the forms of image files that can be sorted based on the National Registration Number, the first six digits of which provides the birth dates. We selected men born on the 20th day of each month with IDs ending with 4 or 6, thereby providing a 1-in-150 sample. Further selections of complete and readable records have provided us with approximately 0.5% sample. For the birth cohorts born from 1946 to 1948, CMRs are available in the forms of micro films. We selected the first 15 films from each roll composed of 3,000 films for these cohorts. If the selected film is incomplete or difficult to read, then we replaced it by the next film.

To protect privacy of the individuals included in the sample, we deleted the following information from the selected CMRs: (1) names of the conscript and family members, (2) military ID, (3) last seven digit numbers of the National Registration Number, and (4) address below the county or district level. To obtain the resulting image files, the front and back pages of CMRs with the sensitive personal information deleted were scanned in MMA. After duplicate records were detected and excluded, we inputted the information drawn from the image files into database.

We identified nine different types of CMRs in terms of format and content. Four major types, denoted as Forms 1 to 4, account for the vast majority of the sample. The variables pertaining to the information on conscripts available from all types of CMR include birth dates, place of current residence, place of original residence, education, occupation, specialty, results of physical examinations and aptitude tests, and conscription decision. The data also provide information on the age, occupation, and relationship to the conscript of parents (or guardian) and other family members. The variables on physical examinations include height, weight, chest measurement, blood pressure, eyesight, and particular health problems.

<Table 2.1>

<Table 2.1> presents the number of samples by birth year. The total number of CMRs collected and scanned in the MMA is 18,359. Of these CMRs, we found 21 records with a missing page and 233 duplicated records. After excluding these defective records, 18,115 CMRs were inputted into machine readable forms. The sample size for each birth cohort ranges from 1,031 (1947 birth cohort) to 2,211 (1957 birth cohort).

2.2. Data on County- and Province-Level Agricultural Productions[5]

Official surveys or statistical reports on agricultural productions in South Korea began publication in the early 1950s. However, agricultural statistics compiled at the county level prior to 1960 only include the number of farm households, farm population, cultivated lands, and irrigation associations. Agricultural productions are provided at the province level.[6] Previous studies that utilized these data are mainly concerned with estimating country-wide trends of agricultural productions (Hwang et al., 2014; Jeong et al., 2015; Jo, 2007; Ko, 2007). The only sources that report county-level agricultural outputs annually and in a consistent manner is the statistical yearbooks published by each province (including two autonomous metropolitan cities at the time, namely, Seoul and Busan) and each county. Accordingly, we constructed county-level agricultural production data set generally from provincial or county statistical year books of various years. Moreover, we supplemented such information with province-level data drawn from other sources, including *Korea Statistical Yearbook*, *Food, Agriculture, Forestry and Fisheries Statistical Yearbook*, and recent statistical reports published in a few regions.

Statistical yearbooks employ a bottom–up approach in the process of producing statistics. Each county compiles data reported from lower public administrative centers and publishes its own statistical yearbook annually. Simultaneously, the related sections or bureaus of each province compiles data reported from the counties they control and publish provincial statistical yearbook annually. Lastly, the National Bureau of Statistics collects all of these data and publishes the *Korean Statistical Yearbook* annually. The *Food, Agriculture, Forestry and Fisheries Statistical Yearbook* is also published via bottom-up approach. This yearbook is published annually by the Ministry of Agriculture after receiving data from local public offices under its jurisdiction and independently conducting the related research and analysis. Lastly, regional authorities occasionally collect and compile previous statistical

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[5] See Lee (2017b) for more detailed methods of data collection and construction of variables.

[6] South Korea had 11 provinces (*Do*) and autonomous metropolitan cities (*Gwangyeoksido*) during the periods under study. These largest administrative divisions are referred to as “province” in this paper. A province is divided into lower administrative units, including cities (*Si*) and counties (*Gun*), whereas metropolitan city and large cities in provinces have multiple districts (*Gu*). County and district are referred to as “county” throughout this paper.

yearbooks and publish new statistical reports.

The records used for our data constructions are available online and in several public libraries. The online sources include the websites of the National Archives of Korea (archives.go.kr), National Assembly Library (nanet.go.kr), Statistics Korea Library (lib1.kostat.go.kr), and several local governments. Many statistical books are deposited in these websites in pdf or e-book files. A few of the records are available only from off-line sources. We collected the records that are unavailable online from the Statistics Korea Library, Suwon Library of Seoul National University, National Assembly Library, and National Archives of Korea either through borrowing volumes or reproducing copies with the permission of the library staff members. Appendix Table A.1 presents the list of the sources utilized for constructing our data on local agricultural productions.

These books provide comprehensive information on the following local statistics presented in figures and tables: (1) short history; (2) land area and climate; (3) population; (4) industry and economy, including agriculture; (5) public employees and finance; (6) water works, health, and cleaning; (7) social welfare; (8) education; (9) public peace; (10) price and national account; (11) communication and electric power; (12) foreign trade and exchange; 13) justice of their territories; and (14) international statistics. Recently published statistical yearbooks provide additional detailed information with improved physical design in statistical figures and tables. However, the basic contents and structure remained unchanged over time. Appendix Table A.2 presents common variables contained in the statistical yearbooks of various provinces and years. Figures 2.2, shows a sample page of the *Seoul Statistical Yearbook* on land area, population, and agriculture, including livestock.

<Figure 2.2>

We selectively inputted the statistics on land area, population, and agriculture, including livestock, which are highly crucial for our empirical analyses to construct data on agricultural productions and nutritional availability by year, province, and county. Country-wide data by year were created by adding province level data of the same years. The *Korea Statistical Yearbook* and *Food, Agriculture, Forestry and Fisheries Statistical Yearbook* were used as secondary sources to input country-wide and province-specific statistics that are missing from provincial or county statistical yearbooks. Appendix Table A.3 introduces the variables on agricultural productions and nutritional availability that were inputted to our data set.

The land areas and agricultural outputs are originally reported in various units that were traditionally used in South Korea. We converted these into meter-units that are currently used. Thereafter, we converted the physical quantities of agricultural outputs into the magnitudes of calories and particular nutrients. In this process, we used the information on calorie and nutrition ingredient per 100 gram of a variety of foods reported in the Korean Food Composition Table (available on the website of the National Institute of Agricultural Sciences: koreanfood.rea.go.kr). Appendix Table A.4 presents the calories and nutrition ingredients per 100 g of selected foods in our data set. Accordingly, we created county- and province-level variables on the availability of total calories, carbohydrates, protein, fats, calcium, phosphorus, iron, potassium, sodium, and vitamins A, B1, B2, B3, and C.

How accurate are these data on agricultural productions? Given that a few of these sources were produced over five decades ago when South Korea was a poor country recovering from the destruction caused by the war, questions arise about the credibility of the sources we relied upon (e.g., see Ko, 2007 and Hwang et al., 2014). Agents conducting public statistical research at the time may lacked the proper skills and knowledge compared with current government employees. A few inconsistencies may arise in the methods of producing statistics across different years and regions.[7]

Nevertheless, we believe that the quality of our data set on agricultural productions is comparable with that of other historical data. We attempted to determine and correct errors in our sources. For example, we crosschecked among different sources providing similar statistics, discovered typos, and differentiated between 0 and missing values. We also analyzed if our data reveal any discontinuous annual changes that cannot be explained by fluctuations in agricultural productions (e.g., natural disasters or poor crop yields). The results of these analyses suggest the quality and credibility of our data. Although constrained by insufficient resources and manpower, the central and local authorities appear to have exerted effort to produce accurate and consistent statistics that were crucial for planning and implementing national and regional policies. At the very least, the records we utilized are the most reliable sources of local food productions that are currently available. For these reasons, we cautiously claim that our data can provide reasonably reliable estimates of local food availability in South Korea from 1950 to 1980.

3. Methods

3.1. Measuring Nutritional Status during Growth Periods

Adult stature is associated with the quantity and quality of diet during periods of human growth and other environmental factors, such as exposure to disease. Two growth periods are particularly important for determining adult height: early childhood from

[7] For instance, the administrative investigation method that had been used until 1974 was replaced by the sample survey method in 1975, thereby possibly causing discontinuity.

conception to 2 years and early adolescence before the onset of puberty. For boys, the second growth spurt occurs between the ages 12 and 16, whereas growth spurt begins early for girls (Abbassi, 1998). The crucial period when adult height is determined is the first growth period in early childhood. The second growth period provides an opportunity for "catch-up growth," which is defined as a more rapid growth than normal for age that follows a period of retardation in early growth. Catch-up growth is generally accepted to be insufficient to completely compensate for deficiencies in early childhood (Perkins et al., 2016). To investigate the association between nutrition and height, we estimated the measures of nutritional intakes separately for two crucial periods of human growth: the first four years in early childhood from conception to age 3 and the five years in early adolescence from age 12 to age 16.

At present, the available data prevent us from connecting the adult height of a person to his or her detailed dietary history during growth. Previous studies inferred the amount of nutritional intakes from the available data on food productions in a particular country or region to establish the relationship between nutritional status and previous health outcomes. Lindert (1994) estimated the per capita food consumption in the UK from 1700 to 1850 by combining the estimates of food productions in England and Wales and statistics on the UK's imports and exports of food items. Floud et al. (2011) estimated the average number of calories for consumption per capita per day in England and Wales from 1700 to 1913 based on crop yields estimated by other scholars. Haines et al. (2003) utilized county-level statistics on farm outputs reported in the US agricultural census and computed the calories and protein productions per adult equivalent per day in each county in the US in the mid-19th century. These studies used the estimates of food consumption as measures of the standard of living and determinants of health outcomes, such as height and mortality.

Following the spirit of previous studies, we inferred nutritional intakes of the conscripts in our sample from the information on food productions in the locality (either county or province) where they lived in early childhood and adolescence. In particular, we estimated the total calories and amounts of major nutrients (including protein, fats, and carbohydrates) for the years covering early childhood (from conception to age 3) and early adolescence (from age 12 to age 16). The county-level statistics on agricultural productions are regularly available only from 1960. Thus, we were unable to obtain county-level measures of nutritional availability in early childhood to match to our conscript sample born from 1946 to 1950. We managed to obtain provincial data on agricultural productions from 1950 on a regular basis. We used these sources to estimate the provincial nutritional availability in early childhood for the individuals born from 1951 to 1957. County-level variables pertaining to nutritional availability in early adolescence are computed for the entire 1946–1957 birth cohorts.

Nutritional requirements differ by gender and age. For example, Fogel (1993) estimated that girls aged 5–9 require two-thirds of the calories needed by males aged 20–39. Given the considerable regional variations in population composition, per capita productions may be misleading measures of true local nutritional availability. Hence, we converted the county or provincial population into adult (prime-age: 20–39) male equivalent population using the estimated average calorie consumption of each age–gender group as a proportion of that of males aged 20–39 (Fogel, 1993, p. 9). In the preceding example, a girl aged 5–9 is counted as a 0.6667 adult male. Age- and gender-specific population of each county and province was used for this computation.

Using the aforementioned calories or amounts of nutrients per adult male equivalent population as an index of food availability implicitly assumes that a person's diet is strongly influenced by the size of locally produced nutrients. However, nutrients can be purchased from other regions if insufficiently produced locally. In particular, urban areas are typically net importers of nutrients even in the past when agricultural markets were not considerably integrated. The size of nutritional production per adult equivalent should be extremely low in large cities, such as Seoul and Busan, where only a small fraction of residents are food producers. Arguably, the market for nutrients in mid-20th century South Korea was likely more tightly integrated than the US agricultural market in the mid-19th-century, when the conventional measure of local nutritional availability was applied (Haines et al., 2003).

We circumvented this problem in the following methods. First, we used calories and amounts of major nutrients per farm household male equivalent population (instead of the entire adult male equivalent population) in each county or province as our primary measure of local nutritional availability. Second, we used several alternative subsamples, the diet of whom was likely influenced by local food productions differently. These subsamples include individuals from counties with their nutritional productions per farm household population above a minimum threshold, men from rural counties, and children of farmers in rural counties. These methods are expected to enable us to reduce the problem of understating food availability in large cities. The size of food production per farm household could be regarded as a crude index of agricultural productivity as well as nutritional availability in the locality. If locally produced nutrients were exported to other regions, then rural counties with a high agricultural productivity could still benefit from increased incomes. In summary, our basic assumption is that an increase in food production per standardized farm household population in a locality improves the nutritional status of residents either through increased food availability or increased income.[8]

[8] Our data sources do not provide age- and gender-specific farm household population for each county. Thus, a standardized farm household population of a county was estimated by multiplying farm household population in the county by the ratio of the adult male equivalent to the total

Table 3.1 explains our measures of nutritional availability. Proxy variables indicating food availability in fetus and infancy include the average productions of calories (calories, infancy), protein (protein, infancy), fat (fat, infancy), and carbohydrates (carbohydrates, infancy) for 4 years (from the year of birth −1 to the year of birth + 2) in the province of residence per farm household adult male equivalent per day. Similarly, the proxy variables for food availability in adolescence include the average productions of calories (calories, adolescence), protein (protein, adolescence), fat (fat, adolescence), and carbohydrates (carbohydrates, adolescence) for 5 years (from age 12 to 16) in the county of residence per farm household adult male equivalent per day. Calories and the three major nutrients per adult male equivalent (where the number of the entire population was applied instead of the number of farm household population) were also employed in our analyses for robustness check.

<Table 3.1>

3.2. Other Explanatory Variables

In addition to access to food, environmental factors, such as prevalence of diseases and sanitary conditions, are important determinants of adult height. Previous historical studies suggest that population and urbanization were closely related to considerably short stature and high mortality in the US, the UK, and other advanced countries until the early 20th century (Fogel, 1991; Wilson and Pope, 2003; Haines et al., 2003; Cain and Hong, 2009). For example, in the mid-19th century US, residents in rural areas stood 3.3 cm taller than city dwellers. The advantages of living in the countryside in the past were generally attributed to considerable isolation from other people, thereby reducing the chances of exposure to infectious diseases and improved access to high-quality foods. Moreover, increased pollution caused by industrialization and inflow of city-bound migrants and policy failures in providing proper public health measures and additional housing in the early stage of urbanization are blamed for the highly unhealthy living conditions in urban areas in the past. Whether this is the case in South Korea in the 1950s and 1960s is unclear. Given the potential positive aspects of urbanization, such as high wages and improved access to markets and medical services, it is an empirical question how urbanization and industrialization were associated with the heights of South Koreans born in the mid-20th century. The current study included the following two variables pertaining to local environmental characteristics: population density (100s of persons per one square kilometer) and percentage of non-farm

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population in the county. We assumed that the age and gender composition of the farm household population in a county follows that of its entire population.

population in the county where the conscript lived at age 14.

The information on conscripts and their family members kept in military records enables the inclusion of characteristics that affected their early life. First, dummy variables indicating the season of birth were constructed based on each conscript's date of birth. Previous studies have established that the season of birth is significantly related to later outcomes, including adult height, perhaps due to seasonal variations in in-utero conditions, such as nutrition and maternal exposure to disease. In general, individuals born in the winter/spring in the Northern Hemisphere are significantly taller than the average of their birth cohort, whereas those born in the final three months of the year are significantly shorter (McGrath et al., 2006; Tanaka et al., 2007). Our analyses classified seasons of birth into four quarters: January to March, April to June, July to September, and October to December.

Second, family size was considered a potential determinant of within-family allocation of nutrients. Previous studies suggest that numerous family members, particularly siblings, tend to reduce parental investments in children (Conley and Glauber, 2006; Lee, 2008). The format of the Korean Military Records hinders the determination of the precise family size or members or siblings. The table concerning family information has only six lines, thereby allowing up to six other family members to be reported. In selecting family members to be included, the parents and grandparents appear to be prioritized (if alive) followed by the siblings. Thus, a few siblings likely failed to be reported for conscripts from large families. For these reasons, the following categorical variables on family size were included in our analysis: one to three, four to six, and seven or above.

Korean Military Records provide a rare opportunity to connect a person's adult height to parental characteristics. We maximized this unusual feature of our data and included the father's occupation as an index of socioeconomic conditions during childhood and adolescence. Given that our data sources were created when the individuals in our sample were approximately age 20, many of their fathers were presumably dead or retired by the time the former was conscripted. Thus, a considerable proportion of conscripts did not provide information on their fathers. Given the importance of the household head in South Korea at the time, it is likely that the majority of them had lost their fathers. The father's occupation is not reported for approximately one-third of the individuals in our sample, although other paternal characteristics (e.g., relationship or age) are provided. No information was provided whether these fathers were out of the labor force or if their jobs were not reported. In our analyses, the father's occupation was classified into the following categories: professional, clerical, service, farming, manual, no job reported, and father absent.

Military records also provide the personal characteristics of conscripts. The most comprehensively reported characteristic is the conscripts' educational attainment, which is missing in only 0.5% of the sample. Children's education is a useful indicator of parental economic status or their investment in children. However, the causal relationship between education and height is not straightforward. Nutritional status in early childhood is generally accepted to exert influence on cognitive ability, school attendance, and academic performances. Case and Paxson (2008) suggested that height at age 16 is a marker of cognitive ability. Thus, inclusion of one's education in height regression is subject to a reverse causality problem. For this reason, we excluded education in our baseline regressions. Instead, education variable was employed only in robustness tests, where education is classified into five categories: primary school or below, middle school, high school, college or higher, and education missing.

3.3. Sample Selection

Table 3.2 compares the measures of food availability and other personal and family characteristics across six selected samples. A total of 17,833 conscripts in the sample were born between 1946 and 1957 and whose date of birth is completely recorded. This sample is defined as the full sample (Col. 1). Of these men, height was successfully identified for 16,838 individuals (Col. 2). Major sample losses also occurred when selecting individuals with information on the county of residence. A total of 13,034 persons survived this selection process. The failure to identify height or county of residence generally resulted from the poor conditions of the original carded military records. The most important predictor of the probability that height or county of residence is unidentified is the year of conscription. Accordingly, the earlier the records produced, the higher the probability of failure.

<Table 3.2>

We selected additional subsamples for regression analyses. Variables on nutritional availability could not be computed in a few counties. We also excluded counties with limited agricultural productions (average calorie production per farm household adult male equivalent per day was below 1000 Kcals in adolescence) and those with extremely high productions (average calorie production per farm household adult male equivalent per day exceeded 20,000 Kcals in adolescence). Approximately 2,500 men who lived in those counties between age 12 and 16 were excluded from the sample, thereby leaving us with 11,508 individuals (Col. 3). This sample with information on height and county-level information on nutritional availability in adolescence is not substantially different from the full sample in terms of personal and family characteristics. However, the latter has slightly limited education and likely to include the fathers' sons.

We further restricted our sample to 7,850 individuals from rural counties with information on height and nutritional availability in adolescence (Col. 4). The excluded urban areas are the districts in metropolitan cities, including Seoul, Busan, Incheon, Daejeon, Gwangju, and Daegu. Given that large cities were excluded, this sample unsurprisingly presents a substantially lower population density and higher nonfarm population share compared with the complete sample. In addition, family size is larger, fathers are more likely to be farmers, and schooling is lower in the sample compared with the complete sample. We made an additional selection to have our baseline sample of 5,560 men from rural counties who were born between 1951 and 1957 (Col. 5). The 1946 to 1950 birth cohorts were excluded to include nutritional availability in infancy and adolescence in regressions because the variables on nutritional productions in infancy are available only for the 1951 to 1957 birth cohorts. Lastly, we used a subsample of 2,784 persons from rural counties who were born between 1951 and 1957 and whose fathers were farmers (Col. 6). We used this sample in the analysis to account for the fact that farmers' children were perhaps most strongly influenced by changes in nutritional production per farm household population.

<Figure 3.1>

Given the potential sample selection bias, the results from the subsamples may not represent the experiences of the entire conscript population, let alone the young male population at large. By contrast, the first three samples (Cols. 1 to 3) are generally similar with one another in terms of personal and family characteristics. The samples restricted to men from rural counties (Cols. 4 to 6) considerably differ from the large samples. However, except for the evident differences in several characteristics that are fully expected from the nature of the sample selection (e.g., low population density, nonfarm population share, and high percentage of persons whose fathers are farmers), the selected subsamples are reasonably comparable to the full sample in terms of height, nutritional availability, family size, and educational attainment. Figure 3.1 shows that the height changes across birth cohorts observed from three different samples (i.e., full sample, sample with county-level nutritional production is available, and rural county sample) are remarkably similar.

4. Nutritional Availability and Height

4.1. Results of the Baseline Regressions with a Rural County Sample

Our baseline regressions are based on a sample of 5,560 men from rural counties who were born between 1951 and 1957 and who have complete information on local nutritional availability in infancy and adolescence. We use this sample to estimate the following equation:

(1) $$H_{i,j,c} = \beta_0 + \beta_1 N^I_{j,c} + \beta_2 N^A_{j,c} + \beta_3 Z_{j.c} + \beta_4 X_{i,j.c} + \varepsilon_{i,j,c},$$

where $H_{i,j,c}$ is the height of the *i*th person from the *j*th county and who belongs to the *c*th birth cohort; $N^I_{j,c}$ and $N^A_{j,c}$ represent the vectors of the variables on nutritional availability in infancy and adolescence, respectively; $Z_{j,c}$ is the vector of the variables on environmental conditions in the county of residence at age 14; $X_{i,j,c}$ are the variables on family and personal characteristics; and $\varepsilon_{i,j,c}$ is the error term. Standard errors were clustered at the county level.

<Table 4.1>

Table 4.1 presents the results of the estimation of the four versions of Equation (1), including the different types of nutrients, namely, calories (Col. 1), protein (Col. 2), fats (Col. 3), and carbohydrates (Col. 4). Except for fats, variables on nutritional availability are all positive and statistically significant. The estimated coefficients indicate a person who spent infancy in a province that produced calories per farm household population one standard deviation (i.e., 711 Kcal) above the mean becomes 0.18 cm tall at age 20 if other factors are equal. One standard deviation high in protein (15.6g) and carbohydrates (154.5g) both during infancy increases adult height by 0.21 cm and 0.18 cm, respectively. The estimated coefficients for food availability in adolescence are smaller than those in infancy. However, the standard deviations for the former are larger than the latter. Consequently, the effects of one standard deviation change in nutritional variables in adolescence and in infancy are similar in magnitude. One standard deviation increase in calories (1.547), protein (0.386), fats (0.107), and carbohydrates (3.421) in the counties where conscripts spent their adolescence is associated with an increase in height at age 20 by 0.20, 0.22, 0.17, and 0.18 cm, respectively.

The population density in the county of residence at age 14 is positively related to adult height, whereas the effect of nonfarm population share on height is negative. The coefficients for these two environment variables are statistically insignificant. The estimated birth season effect is an anticipated one (positive for the second quarter and negative for the fourth quarter), but they are statistically insignificant. Men from families with three or fewer family members are approximately 0.35 cm taller than those with four to six family members. However, the effect of family size is statistically insignificant. Conscripts whose fathers were employed in a clerical job are approximately 1 cm taller than farmers' sons. Having a father engaged in a manual job decreases height by approximately 1.2 cm compared with children of farmers.

<Table 4.2>

Table 4.2 presents the results from additional regressions based on alternative specifications. First, nutritional availability during each of the two stages of growth was included separately in the first two regressions (Panels A and B). Compared with the baseline results (Table 4.1), the effects of nutrition in adolescence (infancy) estimated with and without variables on nutrition in infancy (adolescence) are generally similar, although the magnitudes of the coefficients for nutritional variables increased slightly. This result suggests nutritional status in infancy and in adolescence perhaps independently affected adult height.

The relationship between nutritional availability and height may not be linear as implicitly assumed in baseline regressions. To consider such possibility, a dummy variable indicating each quartile of nutritional availability was included in place of nutrition variable measured in calories or grams (Panel C of Table 4.2). Results show discontinuous changes in heights at certain thresholds of nutritional availability: sharp increase in height between the second and third quartiles of nutrition in infancy and between the lowest and second quartiles of nutrition in adolescence. The estimated coefficients for the fourth quartile of nutrition in infancy are slightly smaller than those for the third quartile. This result suggests the positive effects of nutritional availability in early childhood on height largely captured the difference between individuals in the upper and lower halves in terms of nutritional availability. Similarly, the positive relationship between nutrition in adolescence and height could largely be accounted for by the sharp disparity between the lowest quartile and the rest.

Finally, we investigated how nutritional status during the two different growth periods jointly affected adult height. Therefore, we included dummy variables for four combinations of nutritional availability in infancy and adolescence, namely, low-low, low-high, high-low, and high-high in the regressions. The previous regression results (Panel C) suggest that lowering the nutritional availability below a certain threshold was particularly damaging to growth. Based on the regression results, the bottom 50% in terms of nutritional availability in infancy and the lowest quartile of nutrition in adolescence were classified into "low," and those above the thresholds were classified into "high."

<Figure 4.1>

Such results are reported in Panel D of Table 4.2. In addition, the estimated coefficients for calories and protein are compared visually across nutrition categories in

Figure 4.1. Several features stand out from the results. With the exception of fat, conscripts who belonged to "high" either in infancy or in adolescence are at least 0.5 cm taller than those in the low-low category. Second, high-low individuals are taller than low-high people, confirming that nutrition in infancy is more critical for human growth than nutrition in adolescence. Finally, the marginal effect of changing nutritional status from "low" to "high" is larger in magnitude if nutritional availability in infancy was "low." This result manifests that nutritional intakes in infancy and in adolescence were substitutable. The substitutability between nutritional availability in the two growth periods is revealed more strongly for protein than for calories or carbohydrate. This result indicates remediation in late childhood in the form of improved nutrition was more effective for individuals who had been poorly nourished in early childhood.

4.2. Additional Controls

We analyzed the robustness of the results by including additional controls to Equation (1). Table 4.3 summarizes the results. First, we added the Herfindahl indices of concentration of the sources of calories and three nutrients (i.e., rice, barley, and beef) in the county.[9] Doing so examined if the composition of nutritional sources, not just the quantity, had an influence. Panel A shows the Herfindahl indices of calories, fat, and carbohydrates in infancy and adolescence were negatively associated with height, but the results were uniformly insignificant. Only the Herfindahl indices for protein were positively related to height, but the results were statistically insignificant. Adding the concentration indices to the regressions did not change the coefficients of nutrition quantity variables.

<Table 4.3>

Second, a direct measure of local disease environment was added to the regressions. The degree of exposure to disease in growing ages is regarded as a major determinant of adult height (Wilson and Pope, 2003; Haines et al., 2003). Prior to 1970, when the death registration data began to be provided, reliable local mortality statistics were unavailable. However, the number of individuals who contracted type-1 infectious diseases (typhoid, diphtheria, dysentery, encephalitis, cholera, paratyphoid fever, and typhus) are reported in statistical yearbooks of selected counties and years. Using these sources, we computed the average disease contraction rate (the number of type-1 infectious disease cases per 100,000)

[9] The Herfindahl index is defined as the sum of the squares of the shares of the sources of nutrition. If a given nutrient came entirely from a single source (perfect concentration), then Herfindahl index would equal one. Conversely, if the shares of the sources are equal, the index would equal zero.

in the county where the conscripts lived from 12 to 14 years old. We created a variable for about 54% of the baseline sample because of the imperfect coverage.

We first examined the influences of sample selection by estimating the baseline model with the subsample for whom the local disease contraction rate is available. The coefficients of nutrition variables in infancy diminished in magnitude and lost statistical significance as a consequence of the sample selection (Panel B of Table 4.3). The regression results in which the local disease was included (Panel C of Table 4.3) show the disease variable was not significantly associated with height. Controlling the local disease contraction rate did not noticeably change the coefficients for nutritional availability variables.

Third, educational attainment by age 20 was added to the regressions (Panel D of Table 4.3). Including education variables did not substantially change the baseline results on the effects of nutrition. Magnitudes of the coefficients for food availability in infancy and adolescence diminished only slightly. A high educational attainment was positively related to adult height. Conscripts who entered college were nearly 2 cm taller than those with primary school education or below (control group). Males who attended middle school and those who entered high school were taller than the control group by 0.8 cm and 1.5 cm, respectively.

Finally, province fixed effect was controlled along with own education (Panel E of Table 4.3). Including province dummy variables changed the regression results significantly. Effects of nutritional availability in infancy became considerably large in magnitude when controlling for the province fixed effect. By contrast, coefficients of the variables that capture nutrition in adolescence remained slightly changed in magnitude and lost statistical significance. The reason for the inclusion of province dummy variables strengthening the effects of nutritional availability during early childhood is not entirely evident. A possible explanation is that potential underestimation of nutritional availability in considerably urbanized provinces is fixed in part by including the province fixed effect. Nutrition variables in infancy were created from province-level data. The two largest metropolitan cities, namely, Seoul and Busan, were excluded from the rural county sample, but the agricultural statistics from other provinces still included nutritional productions from all counties, including urban areas. Thus, unlike food availability in adolescence (which was constructed from county-level data), early childhood nutrition variables might be subject to potential “urban bias,” (local nutritional production is low in urban areas, actual food consumption can be high because of imports of nutrients from other regions). We suspect that including the province fixed effect reduced such bias.

4.3. Results from Alternative Samples

A major drawback of the data that served as bases of our analyses was the unknown place of birth. In estimating nutritional availability in infancy, individuals in our sample were assumed implicitly to remain in the same province from birth to conscription. Geographic movements likely produced measurement errors in the nutrition variables that could attenuate their effects on height. To alleviate this potential measurement error, we used a subsample of men from rural counties, the province of residence of whom at the time of conscription is the same as the province of "original family place (*Bonjeok*)." For the birth cohorts born in the 1940s and 1950s, *Bonjeok* presents their fathers' place of birth or residence in the early Japanese colonial period when the modern household registration system was first introduced. Thus, if a conscript's current address and *Bonjeok* are identical, he was likely born in the current province of residence. Of the 13,999 men in our sample for whom the current address and *Bonjeok* are available, approximately 79% reported identical provinces. The percentage of matches is considerably high for the rural country sample (91%), thereby implying that prior geographic mobility of individuals who lived in rural areas at the time of conscription was probably low.[10]

<Table 4.4>

We estimated Equation (1) using a subsample of 5,044 for whom the current and Bonjeok provinces are identical. We expected this additional sample restriction could diminish the magnitude of measurement error resulting from migration. Panel A in Table 4.4 presents similar results to those from the baseline regressions conducted with the full rural county sample. However, the estimated coefficients for nutritional availability, particularly in infancy, are noticeably higher than those obtained from the entire rural county sample (see Table 4.1). If these new estimates are applied, then one standard deviation increase in calories (0.697), protein (0.154), and carbohydrates (1.516) in infancy can increase adult height by 0.21, 0.22, and 0.21 cm, respectively. These effects are slightly higher than the effects drawn from the full rural county sample.

If we select a subsample of conscripts whose nutritional status in the growing ages were most strongly influenced by our measure of local nutritional availability (calories or size of nutrients per farm household adult male equivalent), then such should be men from farm households. We could not determine whether a person lived in a farm household in childhood with available information. Thus, we selected a sample of individuals from rural counties whose fathers were farmers at the time of conscription. This selection process is subject to measurement errors because of possible occupational changes and retirement of the fathers. A

[10] A possible explanation for the low geographic mobility is that the sample used in this study consists of young males who had not finished military service. In South Korea, it is difficult for men to get hired or married before completing military service.

certain proportion of the conscripts who lived in farm households in childhood could be excluded from this subsample if their fathers left farming or retired. However, majority of farmers' sons lived in farm households because of the low probability that people in the 1950s and 1960s transferred from nonfarm occupations to farming. This subsample comprises 2,784 men, which is roughly half the size of our baseline sample.

Panel B in Table 4.4 presents the results of using the subsample of farmers' sons. Nutritional availability in infancy exerts considerably stronger effects on adult height compared with the baseline results. Table 4.1 shows the magnitudes of the effects increased by 70% (protein) to three times (fats). By contrast, the effects of nutrition in adolescence modestly diminished in magnitude and became statistically insignificant. These changes are qualitatively similar to the changes that resulted in the addition of the province fixed effect to the baseline regressions (see Panel E of Table 4.3). The sons of non-farmers came from urbanized places. Therefore, excluding these conscripts would reduce the influences of including urban counties in the estimation of food productions, which is similar to the result of including province fixed effect.

We extended our sample to include conscripts from urban areas where nutritional production per farm population exceeded a minimum threshold. Calories per farm household adult male equivalent in the county (district/city) of residence at age 14 were above 1,000 Kcal. The extended sample of 7,867 conscripts includes men from urban districts with several farm households specializing in agricultural productions. This sample accounts for approximately 90% of the entire sample of the 1951–1957 birth cohorts for whom height and county of residence are available. That is, a relatively small fraction of the entire sample that represents highly urbanized areas were excluded from our analysis.

Panel C in Table 4.4 reports the results of using the extended sample. The estimated effects of the nutrition variables are similar to the results from the baseline regressions performed based on the rural county sample (see Table 4.1). Major exceptions are the effects of protein and fats in adolescence becoming substantially weak in terms of magnitude and statistical significance. This result suggests the significant positive effects of nutritional availability (particularly during early childhood) on height remained visible for a large proportion of the entire population.

In the baseline regressions, the sample was limited to individuals born from 1951–1957, excluding early birth cohorts. The purpose of the sample restriction was to include the analyses of nutrition variables in infancy that were only available for the 1951–1957 birth cohorts. Whether nutritional availability affected the heights of early birth cohorts as much as it did to those born after 1950 remains unclear. Therefore, we conducted height regressions with two separate samples, the 1946–1950 and 1951–1957 cohorts. We included in the regressions only nutritional availability in adolescence available for the entire birth cohorts.

Panel D in Table 4.4 reports that all nutritional availability variables are positive and significant for the sample of early birth cohorts. Two features stand out from comparisons between the results from the two samples with different birth cohorts (see Panel B of Table 4.2 and Panel D of Table 4.4) and between the results from different specifications (regressions with and without including nutrition variables in infancy: Table 4.1 and Panel D of Table 4.4). First, the heights of the early birth cohorts were affected more strongly by local nutritional availability in adolescence than the heights of the cohorts born after 1950. The coefficients for nutrition variables estimated from the sample of the 1946–1950 cohorts (Panel A in Table 4.4) were 50% to 70% higher than those obtained from the sample of the 1951–1957 cohorts (Panel B of Table 4.2). This result suggests marginal benefits of improved nutrition were probably larger for early birth cohorts who were shorter and more severely undernourished than late birth cohorts.

5. Additional Results

5.1. Nutritional Availability and Education

Educational attainment is another key index to consider in determining the effects of early-life nutrition on human capital development. Nutritional status in early childhood is generally accepted to exert influence on cognitive ability, school attendance, and academic performances. Recent literature has established that negative and positive nutrition-related shocks, including mild ones, can substantially affect adult socioeconomic outcomes, including educational attainment and test scores (Almond et al., 2017).

In South Korea, only primary schooling was compulsory prior to 1985, and the 1946–1957 birth cohorts living in rural areas (the baseline sample) were admitted to middle school, high school, and college based on entrance examination scores.[11] Thus, educational attainment by age 20, available from Korean Military Records, was determined in part by cognitive ability of conscripts, not merely by the economic status of their parents.

<Table 5.1>

Applying a model similar to that used in height regressions, we investigated how the years of schooling at conscription was related to nutritional availability in infancy and in adolescence (Table 5.1). Province fixed effect was included in the regressions, considering possible regional differences in supply of and demand for education. Results show all

[11] Exam-free middle school entrance was first put in force in urban areas, Seoul in 1969 and other metropolitan cities in 1970, and were diffused to the entire nation by 1971.

nutrition variables except for fat availability in adolescence had significantly positive effects on educational attainment. One standard deviation change in calories in adolescence was associated with a change in the years of schooling by 0.28 years. An increase in availability of protein in adolescence and carbohydrate in infancy by one standard deviation lengthened schooling by 0.33 years and 0.29 years, respectively.

Moreover, small family size was significantly associated with high educational attainment. The schooling of conscripts living with three or less family members was 0.31 years longer than those with four to six family members. Father's occupation was a strong determinant of years of schooling. Conscripts whose fathers had professional or clerical jobs were educated more than farmers' sons by 1.7 and 2.4 years, respectively. Conscripts with jobless fathers had more schooling than farmers' sons by 0.5 years, whereas absence of father was associated with a decrease in schooling by about 0.3 years.

<Table 5.2>

Education regressions were conducted by adding height at conscription to the baseline model (Table 5.2). Result shows tall individuals were highly educated. One standard deviation increase in height (5.19 cm) was associated with an increase in schooling by 0.33 years. Controlling height did not change the coefficients for nutritional availability in adolescence estimated from the baseline model, thereby suggesting that nutritional status during puberty affects height and education through different pathways. Conversely, except for fat, the effects of nutritional availability in infancy on height diminished in magnitude and became statistically insignificant. A possible explanation for the result is that nutrition in infancy can affect a common determining factor of stature and cognitive ability.

5.2. Remediation: Nutrition in Adolescence and Effect of Exposure to the Korean War

Can increased nutritional availability in late childhood mitigate the negative impact of exposure to negative health shocks sustained in early childhood? The result indicating good substitutability between nutritional intakes in infancy and adolescence (provided in the preceding section: Table 4.2.D) suggests remediation of initial damages in the form of improved nutrition in late childhood would be effective. We attempted to find evidence for remediation by utilizing the experimental episode of the Korean War that majority of the conscripts in our sample experienced in different stages of their childhood.

The Korean War that lasted for three years from June 1950 to July 1953 damaged individual maternal and fetal health, especially in the first 10 months of the war following the surprise invasion of North Korea. The frontline dramatically moved back and forth across the region, forcing civilians to suffer from severe war-related disruptions, such as occupation by enemy, difficulties associated with evacuation, exposure to combats and bombing, and food shortage. Previous studies have established that early-life exposure to the conflict negatively affected educational attainment, labor market performance, and health outcomes (Lee 2014, 2017).

We first estimated the following equation to examine if birth cohorts born in 1950 and 1951 (who were exposed to the worst 10 months of the war during pre-natal and/or neo-natal period) deviated from the neighboring birth cohorts in terms of height, weight, and educational attainment:

(2) $$h_i = \alpha + \sum_{t=1950}^{1951} \beta_t I_{it} + \gamma_1 YOB_i + \gamma_2 YOB_i^2 + \gamma_3 YOB_i^3 + \varepsilon_i ,$$

where h_i denotes the anthropometric or educational outcome for individual *i*; I_t denotes the dummy variable with a value of 1 for individuals born in year *t*, and 0 otherwise; *YOB* denotes the last two digits of the birth year; and β_t measures the departure of outcomes for the birth cohorts *in utero* during the Korean War from the cubic cohort trend. Results in Panel A in Table 5.3 confirm that early-life exposure to the Korean War negatively affected anthropometric and educational outcomes at age 20. Subjects of the 1951 birth cohorts were 0.63 cm shorter, less educated by 0.64 years, and did not enter high school by 11% compared to the adjacent birth cohorts. Similarly, conscripts born in 1950 were 0.7 km lighter, had lower schooling by 0.48 years, and did not enter high school by 5.8% than expected by the cubic cohort trend.

<Table 5.3>

We estimated Equation (3), in which interaction term between dummy variables for 1950 and 1951 birth cohorts and local nutritional availability in adolescence for the corresponding birth cohort (N_{it}) is included.

(3) $$h_i = \alpha + \sum_{t=1950}^{1951} [\beta_t I_{it} + \theta_t (I_{it} \times N_{it})] + \gamma_1 YOB_i + \gamma_2 YOB_i^2 + \gamma_3 YOB_i^3 + \varepsilon_i .$$

The estimated equation $\beta_t + (\theta_t \times N_{it})$ shows the magnitude of deviation from smooth cohort trend of the subjects of the birth cohort born in year *t* (either 1950 or 1951) who spent adolescence in counties with a particular quantity of local nutritional availability.

Panel B of Table 5.3 shows that interaction terms (θ_t) are positive and statistically significant wherever the coefficient for each cohort dummy (β_t) was estimated as significantly negative. This result suggests the negative cohort effects of early exposure to the Korean War were small for those who lived in counties with high nutritional availability during adolescence. Such result also provides suggestive evidence that improved nutrition in late childhood effectively compensated for the negative consequences of early exposure to negative shocks caused by the war.

5.3. Contribution of Improved Nutrition to Increase in Adult Height across Cohorts

Section 4 suggests that local nutritional availability in growth periods is an important determinant of adult height. The average height of South Korean conscripts rapidly increased between the cohort born in 1951 and those born in 1957. For six years, approximately 2 cm was gained. Given that about 6 cm was gained during the next 30 years (0.2 cm per year), the increase in height experienced by males born between 1951 and 1957 (0.33 centimeters per year) was considerably rapid in long-run perspective.[12] As expected from the process of recovery from the aftermath of the Korean War and the increased income and agricultural productivity that followed, the quality and quantity of diet in childhood and adolescence improved across birth cohorts. Our final question is how much improved nutrition contributed to the rapid increase in height of the birth cohorts under investigation.

<Table 5.4>

We conducted an exercise to obtain a back-of-envelope estimate on how improved nutrition in growing ages contributed to the increase in heights of conscripts. By using the largest-possible sample for whom nutritional availability in infancy and adolescence is provided (a sample of 7,867 men used in the regressions reported in Panel C of Table 4.4), we first computed the measures of nutritional availability for each cohort from 1951–1957 (see Panels A to G in Table 5.4) and the magnitude of increase in each measure (see Panel H in Table 5.4). For example, calories available in infancy increased by 1,465 Kcals between the 1951 and 1957 cohorts. Thereafter, we multiplied the size of the increase by the estimated regression coefficient for the corresponding nutrition variable. We then calculated the magnitude of height change predicted by an increase in the measure of nutrition. The regression results from using the same sample of 7,867 conscripts (see Panel C in Table 4.4) were used.

Result suggests improved nutrition in growth periods, particularly in early childhood,

[12] The average height at age 20 by year of birth from the late 1950s was obtained from survey reports of the Korea Research Institute of Standards and Science that began to be published from 1979.

might have contributed substantially to an increase in height from 1951–1957. First, increased calorie availability increased adult height by approximately 0.6 cm. Majority (0.52 cm) of this contribution is attributable to the increased calories in infancy. Moreover, changes in the availability of protein, fats, and carbohydrates resulted in an increase in adult height by 0.5 cm, 0.19 cm, and 0.49 cm, respectively. Given the four measures of nutritional availability are correlated to one another, estimating the combined effect of calories and various nutrients is difficult. If only the effect of calories is concerned, then nutritional improvement accounts for 30% of the increase in average height between the 1951 and 1957 cohorts (i.e., approximately 2 cm). If we assume the three major nutrients (i.e., protein, fat, and carbohydrates) independently contributed to height change, then their joint effect increases height by 1.1 cm. By applying large estimates of the effect of nutritional availability from using alternative samples (e.g., sample of farmers' sons: Panel B in Table 4.4) or specifications (e.g., adding province fixed effect: Panel E of Table 4.3), the contribution of nutritional improvement becomes more important.

6. Conclusion

This study investigated how nutritional availability in two crucial periods for human growth, namely, early childhood (from conception to age 3) and adolescence (from age 12 to age 16), affected the heights of South Korean conscripts born from 1946 to 1957. We constructed and utilized province- and county-level data on agricultural production and matched the data set with sample of conscripts using information on place of residence. The amounts of calories and three major nutrients (i.e., protein, fats, and carbohydrates) per farm household adult equivalent in a given province or county were used as our primary measures of local nutritional availability.

The results suggest nutrition was an important determining factor of biological standards of living indicated by adult height. Provisions of calories and major nutrients were strongly associated with large stature. Food availability during early childhood was more critical for human growth than nutrition in adolescence. This result is consistent with the consensus that catch-up growth in adolescence is insufficient to compensate completely for deficiencies in early childhood. The marginal effect of increasing nutritional availability in adolescence was large in magnitude if nutritional availability in infancy was low, which manifests that nutritional intakes in two growth periods are substitutable.

We also investigated how educational attainment was related to nutritional availability in infancy and in adolescence. Results show all nutrition variables except for fat availability in adolescence had significantly positive effects on educational attainment. Controlling height did not change the coefficients for nutritional availability in adolescence estimated from the baseline model, suggesting that nutritional status during puberty affects height and education through different pathways. Conversely, the effects of nutritional availability in early childhood on height diminished in magnitude and became statistically insignificant. A possible explanation for the result is that nutrition in early childhood can affect a common determining factor of stature and cognitive ability.

We explored whether increased nutritional availability in late childhood can mitigate the negative impact of exposure to negative health shocks sustained in early childhood, utilizing the experimental episode of the Korean War. Result suggests the negative cohort effects of early exposure to the Korean War were small for those who lived in counties with high nutritional availability during adolescence. This result provides suggestive evidence that improved nutrition in late childhood effectively compensated the negative consequences of early exposure to negative shocks caused by the war.

Finally, we examined the extent by which improved nutrition contributed to the increase in height between the 1951 and 1957 birth cohorts. To estimate the contribution of improved nutrition to the increase in height, we computed the change in height predicted by the change in nutrition using height regression results and estimated change in each nutritional availability variable between 1951 and 1957. Result suggests improved nutrition in early childhood and adolescence accounted for 30% to 50% of the increase in adult height that was gained from the 1951–1957 birth cohorts. Increased nutritional availability during early childhood explains majority of the contribution.

The results of the study suggest that improvements in the quantity and quality of nutritional intakes made possible by increased incomes and enhanced agricultural productivity significantly contributed to the increase in the biological standard of living in South Korea. Robert Fogel’s pioneering research has established that increased nutrition was a key factor of the long-term improvements in health and productivity in western developed countries (Fogel 2004; Floud et al. 2011). His insights look remarkably relevant for understanding the historical experiences of a newly-developed country with much different socioeconomic and institutional backgrounds.

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Table 2.1.
Number of Military Records by Year of Birth

Year of Birth	(A) Number of Records Collected	(B) Number of Incomplete Records	(C) Number of Duplicated Records	(D) Number of Records Inputted
1946	1,162	0	4	1,158
1947	1,036	0	5	1,031
1948	1,443	1	1	1,441
1949	1,143	0	23	1,120
1950	1,310	1	5	1,304
1951	1,303	0	43	1,260
1952	1,577	0	2	1,575
1953	1,404	11	35	1,358
1954	1,706	4	6	1,696
1955	1,875	0	52	1,823
1956	2,157	1	18	2,138
1957	2,243	3	29	2,211
Total	18,359	21	223	18,115

Source: Sample of Korean Military Records.

Table 3.1
Definition of Variable

Variable	Definition
Height	Height at age 20 (in centimeter)
Food availability in fetus & infancy	
Calories, Infancy	Average calorie production for 4 years (from prenatal period to age 2) in the province of residence (1000s of kcals per farm household adult male equivalent per day).
Protein, Infancy	Average protein production for 4 years (from prenatal period to age 2) in the province of residence (100s of grams per farm household adult male equivalent per day).
Fat, Infancy	Average fat production for 4 years (from prenatal period to age 2) in the state of residence (100s of grams per farm household adult male equivalent per day).
Carb, Infancy	Average carbohydrate production for 4 years (from prenatal period to age 2) in the state of residence (100s of grams per farm household adult male equivalent per day).
Food availability in adolescence	
Calories, Adolescence	Average calorie production for 5 years (from age 12 to age 16) in the county of residence (1000s of kcals per farm household adult male equivalent per day).
Protein, Adolescence	Average protein production for 5 years (from age 12 to age 16) in the county of residence (100s of grams per farm household adult male equivalent per day).
Fat, Adolescence	Average fat production for 5 years (from age 12 to age 16) in the county of residence (100s of grams per farm household adult male equivalent per day).
Carb, Adolescence	Average carbohydrate production for 5 years (from age 12 to age 16) in the county of residence (100s of grams per farm household adult male equivalent per day).
Environmental characteristics	
Population density	Population (100s of persons) per 1 square kilometers in the county of residence at age 14.
Nonfarm population share	The share of nonfarm population (percent) in the county of residence at age 14.
Seasonality of birth	
First quarter	Equals 1 if born from January to March.
Second quarter	Equals 1 if born from April to June.
Third quarter	Equals 1 if born from July to September.
Fourth quarter	Equals 1 if born from October to December.
Family size	
Number of family 1-3	Equals 1 if two or less family members are reported.
Number of family 4-6	Equals 1 if three to five family members are reported.
Number of family 7 or more	Equals 1 if six family members are reported.
Father's occupation	
Professional	Equals 1 if father had a professional or managerial job.
Clerical	Equals 1 if father had a semi-professional or clerical job.
Service	Equals 1 if father had a service job.
Farming	Equals 1 if father's occupation was farmer.
Manual	Equals 1 if father had a manual job.
No job reported	Equals 1 if father's job is not reported.
Father absent	Equals 1 if father was absent.

Table 3.2
Comparison of Selected Samples

	(1) Full Sample	(2) Information on height	(3) Height + County (nutrition in adolescence)
Measure of net nutritional status			
Height (centimeter)		166.446	166.408
Food availability in fetus & infancy			
Calories (1000s of Kcal)			
Protein (100s of grams)			
Fat (100s of grams)			
Carbohydrate (100s of grams)			
Food availability in adolescence			
Calories (1000s of Kcal)			4.380
Protein (100s of grams)			1.211
Fat (100s of grams)			0.270
Carbohydrate (100s of grams)			8.987
Environmental characteristics			
Population density (100s/km^2)			20.298
Nonfarm population share (%)			45.661
Seasonality of birth (proportion)			
First quarter	0.286	0.284	0.284
Second quarter	0.230	0.231	0.232
Third quarter	0.242	0.242	0.238
Fourth quarter	0.242	0.242	0.246
Family size (proportion)			
Number of family 1-3	0.096	0.092	0.087
Number of family 4-6	0.609	0.611	0.610
Number of family 7 or more	0.295	0.297	0.303
Father's occupation (proportion)			
Professional	0.007	0.007	0.006
Clerical	0.024	0.024	0.022
Service	0.005	0.005	0.005
Farming	0.391	0.389	0.415
Manual	0.023	0.023	0.022
No job reported	0.341	0.343	0.328
Father absent	0.204	0.204	0.328
Own education (proportion)			
Primary school or less	0.239	0.242	0.254
Middle school	0.282	0.283	0.287
High school	0.363	0.363	0.355
College	0.112	0.108	0.101
Education missing	0.004	0.004	0.003
Number	17833	16838	11508

Table 3.2
Comparison of Selected Samples (Continued)

	(4) Rural counties	(5) Rural counties, 1951-1957 cohorts	(6) Farmer's sons in rural counties, 1951-1957 cohorts
Measure of net nutritional status			
Height (centimeter)	166.338	166.656	166.731
Food availability in fetus & infancy			
Calories (1000s of Kcal)		2.811	2.880
Protein (100s of grams)		0.698	0.714
Fat (100s of grams)		0.113	0.115
Carbohydrate (100s of grams)		5.958	6.107
Food availability in adolescence			
Calories (1000s of Kcal)	4.662	5.090	5.132
Protein (100s of grams)	1.146	1.257	1.248
Fat (100s of grams)	0.187	0.207	0.195
Carbohydrate (100s of grams)	9.921	10.832	10.960
Environmental characteristics			
Population density (100s/km^2)	4.663	5.155	3.181
Nonfarm population share (%)	25.922	26.240	22.490
Seasonality of birth (proportion)			
First quarter	0.287	0.284	0.290
Second quarter	0.234	0.235	0.229
Third quarter	0.235	0.234	0.238
Fourth quarter	0.244	0.247	0.243
Family size (proportion)			
Number of family 1-3	0.077	0.064	0.023
Number of family 4-6	0.601	0.614	0.600
Number of family 7 or more	0.321	0.322	0.377
Father's occupation (proportion)			
Professional	0.004	0.004	0
Cleric	0.016	0.018	0
Service	0.003	0.003	0
Farming	0.512	0.501	1.000
Manual	0.013	0.015	0
No job reported	0.260	0.279	0
Father absent	0.189	0.177	0
Own education (proportion)			
Primary school or less	0.295	0.281	0.299
Middle school	0.306	0.307	0.323
High school	0.329	0.343	0.329
College	0.067	0.067	0.048
Education unreported	0.003	0.001	0.001
Number	7850	5560	2784

Source. Sample of Korean Military Records matched with province- and county-level data on nutritional availability.

Table 4.1
Local Nutritional Availability and Height: 1951-1957 Birth Cohort in Rural Counties

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
Intercept	165.4625***	165.2796***	166.4755***	165.4818***
	(0.3999)	(0.4309)	(0.3309)	(0.3945)
Local Nutritional availability				
Nutrition, Infancy	0.2546**	1.3243***	1.7949	0.1186**
	(0.0995)	(0.4415)	(2.5847)	(0.0458)
Nutrition, Adolescence	0.1303**	0.5698***	1.5865*	0.0585**
	(0.0497)	(0.1941)	(0.9061)	(0.0226)
Local environment				
Population density	0.01689	0.0165	0.0120	0.0169
	(0.0121)	(0.0115)	(0.0113)	(0.0122)
Nonfarm population share	-0.0051	-0.0082	-0.0100	-0.0043
	(0.0084)	(0.0081)	(0.0070)	(0.0085)
Season of Birth				
First quarter	NI	NI	NI	NI
Second quarter	0.2235	0.2253	0.2134	0.2234
	(0.1791)	(0.1795)	(0.1773)	(0.1790)
Third quarter	-0.2126	-0.2019	-0.1925	-0.2141
	(0.1688)	(0.1682)	(0.1688)	(0.1689)
Fourth quarter	-0.3076	-0.3069	-0.3124	-0.3081
	(0.2109)	(0.2103)	(0.2113)	(0.2110)
Family size				
1 to 3	0.3611	0.3733	0.3368	0.3593
	(0.3377)	(0.3389)	(0.3400)	(0.3376)
4 to 6	NI	NI	NI	NI
7 or more	0.0169	0.0082	0.0115	0.0192
	(0.1494)	(0.1501)	(0.1516)	(0.1494)
Father's occupation				
Professional	-0.1198	-0.0932	-0.0897	-0.1262
	(0.9222)	(0.9256)	(0.9325)	(0.9211)
Clerical	1.0196**	1.0070**	1.0074**	1.0212**
	(0.4777)	(0.4787)	(0.4765)	(0.4774)
Service	-0.9528	-0.9629	-0.8128	-0.9545
	(1.6111)	(1.6141)	(1.6371)	(1.6100)
Farming	NI	NI	NI	NI
Manual	-1.2294**	-1.2309**	-1.2340**	-1.2296**
	(0.5973)	(0.5966)	(0.5923)	(0.5973)
No job	-0.2662	-0.2574	-0.2961*	-0.2667
	(0.1735)	(0.1730)	(0.1735)	(0.1736)
Father absent	-0.1025	-0.0935	-0.1079	-0.1044
	(0.2029)	(0.2026)	(0.2035)	(0.2030)
R-square	0.0075	0.0080	0.0051	0.0075
F-value	3.54***	3.75***	2.76***	3.53***
N	5560	5560	5560	5560

Significance level. * 10%, ** 5%, *** 1%.

Table 4.2
Local Nutritional Availability and Height: Alternative Specifications

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
(A) Infancy only				
Nutrition, Infancy	0.3280***	1.5530***	3.6797	0.1511***
	(0.0973)	(0.4321)	(2.5611)	(0.0448)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0061	0.0063	0.0068	0.0090
F-value	3.74***	3.82***	6.21***	6.31***
N	5560	5560	5560	5560
(B) Adolescence only				
Nutrition, Adolescence	0.1610***	0.6570***	1.8159**	0.0725***
	(0.0508)	(0.2024)	(0.8880)	(0.0231)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0064	0.0065	0.0050	0.0063
F-value	3.20***	3.34***	2959***	3.19***
N	5560	5560	5560	5560
(C) Categorical variable				
Second quartile, infancy	-0.1361	-0.0085	-0.0793	-0.1420
	(0.1939)	(0.2074)	(0.2553)	(0.1974)
Third quartile, infancy	0.3890*	0.4281**	0.1877	0.4730**
	(0.2182)	(0.1927)	(0.2309)	(0.2233)
Highest quartile, infancy	0.4047*	0.3408	0.5211**	0.3687*
	(0.2112)	(0.2104)	(0.2405)	(0.2127)
Second quartile, Adolescence	0.5211***	0.8108***	0.0375	0.3290*
	(0.1856)	(0.1780)	(0.2207)	(0.1825)
Third quartile, Adolescence	0.5359***	0.7013***	-0.1329	0.4851**
	(0.2010)	(0.1940)	(0.2077)	(0.2032)
Highest quartile, Adolescence	0.6296***	0.6380***	-0.0102	0.5823***
	(0.2015)	(0.1879)	(0.9636)	(0.2073)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0095	0.0102	0.0059	0.0091
F-value	5.17***	3.95***	2.64***	3.07***
N	5560	5560	5560	5560
(D) Infancy / Adolescence				
Low / High	0.5187**	0.5848***	-0.2599	0.5519***
	(0.1986)	(0.2006)	(0.2218)	(0.2009)
High / Low	0.6755***	0.8314***	0.1971	0.7400***
	(0.2125)	(0.2178)	(0.2198)	(0.2088)
High / High	0.8511***	0.7044***	0.3129*	0.8847***
	(0.1990)	(0.1979)	(0.1782)	(0.1992)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0084	0.0083	0.0055	0.0088
F-value	3.22***	3.10***	2.63***	3.27***
N	5560	5560	5560	5560

Significance level. * 10%, ** 5%, *** 1%.

Table 4.3
Local Nutritional Availability and Height: Additional Controls

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
(A) Variety of sources (HI)				
Nutrition, Infancy	0.2983**	1.1501**	2.1780	0.1333**
	(0.1234)	(0.4993)	(2.7865)	(0.0562)
Nutrition, Adolescence	0.1474**	0.8656***	1.6374	0.0621**
	(0.0599)	(0.2983)	(1.0771)	(0.0264)
HI, Infancy	-1.8037	1.2664	-0.5522	-1.2606
	(1.7034)	(1.1713)	(1.3210)	(1.5826)
HI, Adolescence	-0.0551	1.0507	-0.4322	-0.1367
	(0.5452)	(0.6530)	(0.8840)	(0.5622)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0078	0.0089	0.0052	0.0076
F-value	3.29***	3.35***	2.82***	3.32***
N	5560	5560	5560	5560
(B) Sample with information on local disease rate				
Nutrition, Infancy	0.1055	0.6238	-1.3216	0.0520
	(0.1326)	(0.6238)	(3.5939)	(0.0610)
Nutrition, Adolescence	0.1575**	0.5689**	1.8257	0.0725**
	(0.0736)	(0.2772)	(1.4284)	(0.0338)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0106	0.0105	0.0084	0.0107
F-value	2.11**	2.16**	1.95**	2.10**
N	3025	3025	3025	3025
(C) Local disease rate				
Nutrition, Infancy	0.1036	0.6290	-1.0079	0.0509
	(0.4357)	(0.5872)	(3.6830)	(0.0609)
Nutrition, Adolescence	0.1612**	0.6135**	1.9076	0.0739**
	(0.0743)	(0.2787)	(1.4357)	(0.0341)
Local disease rate	0.0025	0.0027	0.0022	0.0023
	(0.0071)	(0.0071)	(0.0075)	(0.0071)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0107	0.0106	0.0085	0.0107
F-value	1.97**	2.02**	1.84**	1.97**
N	3025	3025	3025	3025
(D) Own education				
Nutrition, Infancy	0.2305**	1.1955***	1.7589	0.1070**
	(0.0977)	(0.4375)	(2.6168)	(0.0449)
Nutrition, Adolescence	0.0994**	0.4731**	1.5002*	0.0440*
	(0.0497)	(0.1955)	(0.9050)	(0.0226)
Middle school	0.8319***	0.8309***	0.8698***	0.8314***
	(0.1706)	(0.1707)	(0.1702)	(0.1705)
High school	1.4880***	1.4896***	1.5366***	1.4871***
	(0.1724)	(0.1721)	(0.1714)	(0.1724)
College	1.9143***	1.9163***	1.9549***	1.9147***
	(0.2998)	(0.2994)	(0.2996)	(0.2998)
Education Missing	3.1830*	3.1976*	3.1837	3.1774*
	(1.9007)	(1.8995)	(1.9253)	(1.9007)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0227	0.0232	0.0212	0.0226
F-value	10.49***	10.91***	9.57***	10.44***
N	5560	5560	5560	5560

Significance level. * 10%, ** 5%, *** 1%.

Table 4.3

Local Nutritional Availability and Height: Additional Controls (Continued)

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
(E) Education & Province				
Nutrition, Infancy	0.7592***	3.0234***	7.8572*	0.3570***
	(0.1595)	(0.7187)	(2.6168)	(0.0729)
Nutrition, Adolescence	0.1187	0.4278	1.7740	0.0535
	(0.0822)	(0.3591)	(1.4385)	(0.0370)
Education	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes
Province dummy	Yes	Yes	Yes	Yes
R-square	0.0227	0.0282	0.0240	0.0292
F-value	10.49***	10.04***	8.61***	10.48***
N	5560	5560	5560	5560

Significance level. * 10%, ** 5%, *** 1%.

Table 4.4
Local Nutritional Availability and Height: Alternative Samples

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
(A) Living in province of family place (*Bonjeok*)				
Nutrition, Infancy	0.3010***	1.4468***	0.8730	0.1414***
	(0.1011)	(0.4478)	(2.5709)	(0.0465)
Nutrition, Adolescence	0.1370***	0.5923***	1.7227*	0.0617***
	(0.0515)	(0.1973)	(0.9057)	(0.0234)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0078	0.0081	0.0047	0.0078
F-value	3.13***	3.19***	2.26***	3.15***
N	5044	5044	5044	5044
(B) Farmers' Sons in rural counties				
Nutrition, Infancy	0.4594***	2.2225***	5.8666	0.2106***
	(0.1435)	(0.6180)	(3.6528)	(0.0663)
Nutrition, Adolescence	0.0913	0.4459*	0.9934	0.0398
	(0.0677)	(0.2523)	(1.1792)	(0.0311)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0077	0.0083	0.0040	0.0075
F-value	5.29***	5.87***	2.49**	5.19***
N	2784	2784	2784	2784
(C) All persons with local nutritional productions				
Nutrition, Infancy	0.3570***	1.0424***	1.3876*	0.1405***
	(0.0923)	(0.3138)	(0.7584)	(0.0423)
Nutrition, Adolescence	0.0760*	0.1181	-0.0902	0.0427**
	(0.0438)	(0.1057)	(0.1810)	(0.0202)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0074	0.0067	0.0050	0.0069
F-value	4.53***	3.80***	2.93***	4.42***
N	7867	7867	7867	7867
(D) 1946-1950 birth cohorts				
Nutrition, Adolescence	0.2390***	1.0066***	3.2564***	0.1078***
	(0.0455)	(0.1892)	(0.8288)	(0.0206)
Other controls	Yes	Yes	Yes	Yes
R-square	0.0092	0.0095	0.0068	0.0090
F-value	6.31***	6.75***	6.21***	6.31***
N	7850	7850	7850	7850

Significance level. * 10%, ** 5%, *** 1%.

Table 5.1

Local Nutritional Availability and Education: 1951-1957 Birth Cohort in Rural Counties

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
Intercept	9.9545***	9.8648***	8.9954***	9.9364***
	(1.0990)	(1.4344)	(1.2912)	(1.0233)
Local Nutritional availability				
Nutrition, Infancy	0.1732*	0.8449*	6.3710**	0.0793*
	(0.0957)	(0.4337)	(2.5340)	(0.0437)
Nutrition, Adolescence	0.1793***	0.5418***	0.3781	0.0840***
	(0.0451)	(0.2075)	(1.0112)	(0.0203)
Local environment				
Population density	-0.0307	-0.0310	-0.0052	-0.0284
	(0.0209)	(0.0278)	(0.0288)	(0.0193)
Nonfarm population share	0.0066	0.0060	0.0047	0.0065
	(0.0049)	(0.0049)	(0.0049)	(0.0049)
Season of Birth				
First quarter	NI	NI	NI	NI
Second quarter	0.0631	0.0632	0.0552	0.0625
	(0.0899)	(0.0893)	(0.0898)	(0.0899)
Third quarter	0.1317	0.1387	0.1404	0.1309
	(0.1008)	(0.1008)	(0.1008)	(0.1008)
Fourth quarter	0.0301	-0.0339	-0.0404	-0.0302
	(0.0917)	(0.0919)	(0.6620)	(0.0916)
Family size				
1 to 3	0.3152**	0.3149**	0.3011*	0.3148**
	(0.1541)	(0.1542)	(0.1545)	(0.1541)
4 to 6	NI	NI	NI	NI
7 or more	0.1624*	-0.1704**	-0.1812**	-0.1614*
	(0.0827)	(0.0819)	(0.0835)	(0.0827)
Father's occupation				
Professional	1.7458***	1.7758***	1.7816***	1.7418***
	(0.6031)	(0.6067)	(0.6109)	(0.6027)
Clerical	2.3718***	2.3674***	2.3935***	2.3738***
	(0.2058)	(0.2069)	(0.2066)	(0.2055)
Service	0.4717	0.4653	0.5444	0.4747
	(0.8630)	(0.8665)	(0.8708)	(0.8619)
Farming	NI	NI	NI	NI
Manual	0.0998	0.0846	0.0654	0.1009
	(0.3118)	(0.3115)	(0.3150)	(0.3121)
No job	0.5139***	0.5201***	0.5204***	0.5128***
	(0.1019)	(0.1032)	(0.1024)	(0.1017)
Father absent	-0.2827**	-0.2828**	-0.2949***	-0.2832***
	(0.1105)	(0.1108)	(0.1101)	(0.1105)
Province fixed effect	Yes	Yes	Yes	Yes
R-square	0.0475	0.0425	0.0391	0.0449
F-value	38.27***	37.12***	34.76***	38.52***
N	5553	5553	5553	5553

Significance level. * 10%, ** 5%, *** 1%.

Table 5.2
Local Nutritional Availability and Education with Controlling for Height:
1951-1957 Birth Cohort in Rural Counties

Variable	(1) Calories	(2) Protein	(3) Fat	(4) Carbohydrate
Intercept	-0.6207	-0.7651	-1.8740	-0.6377
	(1.3558)	(1.6017)	(1.5151)	(1.3059)
Local Nutritional availability				
Calories, Infancy	0.1213	0.6330	5.7228**	0.0550
	(0.0932)	(0.4226)	(2.4857)	(0.0426)
Calories, Adolescence	0.1692***	0.5067**	0.2528	0.0793***
	(0.0445)	(0.2068)	(1.010)	(0.0201)
Height	0.0636***	0.0641***	0.0658***	0.0636***
	(0.0061)	(0.0062)	(0.0062)	(0.0061)
Other Controls	Yes	Yes	Yes	Yes
Province fixed effect	Yes	Yes	Yes	Yes
R-square	0.0575 0.0597	0.0573	0.0549	0.0595
F-value	41.51***	40.49***	38.20***	41.85***
N	5553	5553	5553	5553

Significance level. * 10%, ** 5%, *** 1%.

Table 5.3
Early-Life Exposure to the Korean War, Local Nutritional Availability in Adolescence, and Human Capital Outcomes at Conscriptions: Farmers' Sons from Rural Counties

Variable	(1) Height	(2) Weight	(3) Years of schooling	(4) High school entrance
(A)				
1950	-0.2993	-0.7003*	-0.4826**	-0.0580*
	(0.3439)	(0.3919)	(0.1950)	(0.0338)
1951	-0.6252*	-0.5710	-0.6401***	-0.1097***
	(0.3301)	(0.3894)	(0.1877)	(0.0311)
Cubic cohort trend, Birth month	Yes	Yes	Yes	Yes
R-square	0.0244	0.0064	0.0123	0.0080
F-value	5.97***	2.05**	3.30***	2.34***
N	4016	3879	4008	4008
(B)				
1950	-0.2913	-2.7762**	-1.1346**	-0.1014*
	(1.0372)	(1.1667)	(0.5258)	(0.0966)
1950 × Calories, Adolescence	0.0028	0.5083*	0.1597	0.0106
	(0.2339)	(0.2841)	(0.1137)	(0.0211)
1951	-2.5892**	-0.5199	-2.1029***	-0.2811***
	(1.1637)	(1.1425)	(0.6344)	(0.0871)
1951 × Calories, Adolescence	0.4864*	-0.0130	0.3621**	0.0424**
	(0.2642)	(0.2893)	(0.1441)	(0.0189)
Cubic cohort trend, Birth month	Yes	Yes	Yes	Yes
R-square	0.0252	0.0073	0.0144	0.0102
F-value	5.55***	2.16***	3.27***	2.03**
N	4016	3879	4008	4008

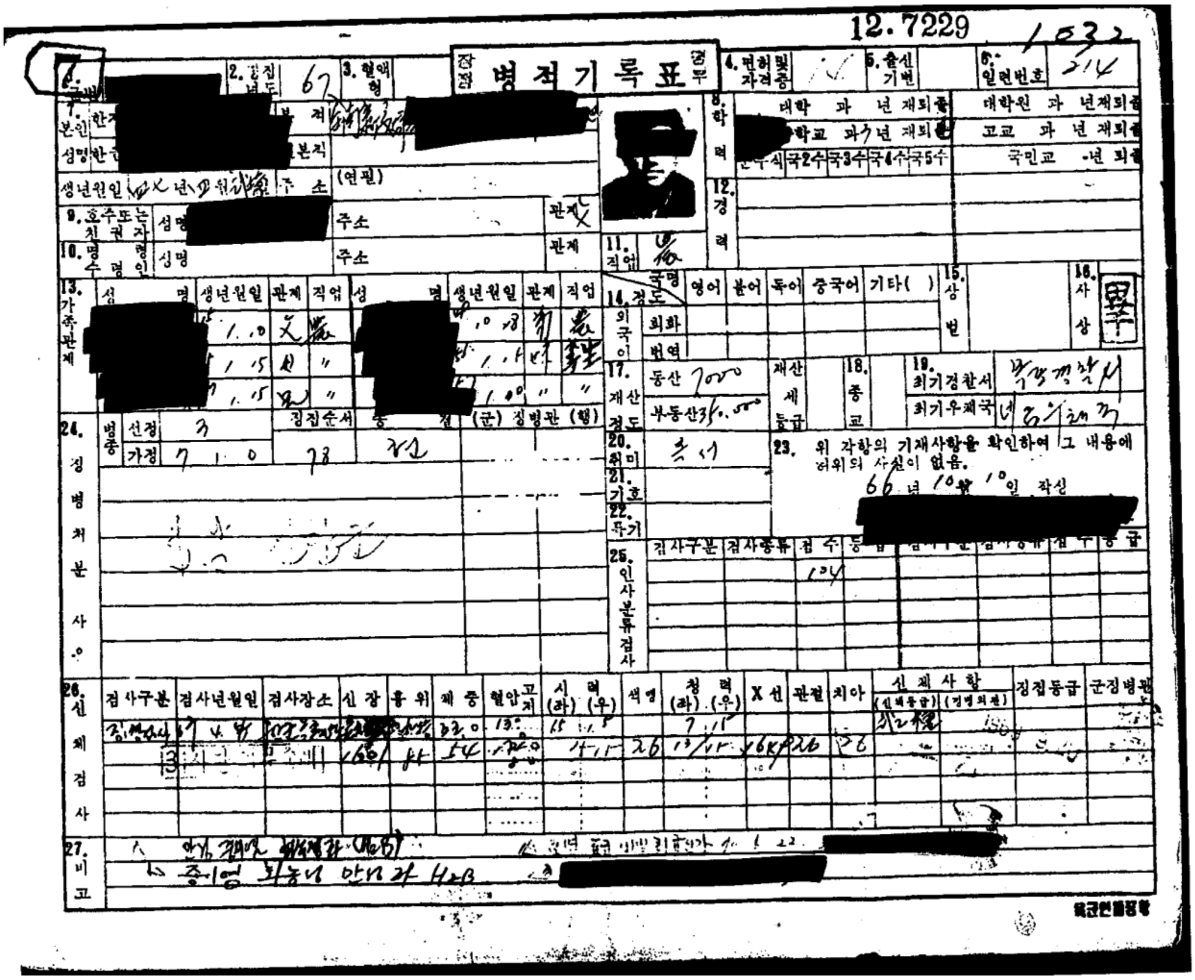
Significance level. * 10%, ** 5%, *** 1%.

Table 5.4.
Height Change Predicted by Increase in Nutritional Production

	(1) Calories (1000Kcals)		(2) Protein (100g)		(3) Fat (100g)		(4) Carbohydrate (100g)	
	Age -1 to 3	Age 12-16	Age -1 to 3	Age 12-16	Age -1 to 3	Age 12-16	Age -1 to 3	Age 12-16
A. 1951 cohort	1.876	4.011	0.491	1.057	0.085	0.223	3.958	8.296
B. 1952 cohort	2.260	4.361	0.603	1.189	0.111	0.261	4.731	8.973
C. 1953 cohort	2.511	4.747	0.686	1.318	0.133	0.305	5.222	9.698
D. 1954 cohort	2.678	4.773	0.711	1.311	0.136	0.297	5.576	9.792
E. 1955 cohort	2.818	4.929	0.766	1.363	0.154	0.304	5.823	10.121
F. 1956 cohort	3.304	4.910	0.919	1.372	0.191	0.318	6.793	10.042
G. 1957 cohort	3.341	5.002	0.968	1.299	0.218	0.242	6.777	10.521
H. Change (G-A)	1.465	0.991	0.477	0.242	0.133	0.019	2.819	2.225
I. Regression Coefficient	0.357	0.076	1.042	0.118+	1.388	-0.090+	0.141	0.043
J. Predicted height change (H×I)	0.523	0.074	0.497	0	0.185	0	0.397	0.096

Note. The sample includes 11508 persons born between 1951 and 1957 with information on height and nutritional availability in both infancy (age -1 to 3) and in early adolescence (age 12 to 16). The coefficients for variables regarding local nutritional production are from the regressions conducted based on the same sample (Panel C of Table 4.4). The mean height of this sample is 165.48cm for 1951 and 167.42cm for 1957.

Figure 2.1
Sample of Carded Military Record



12.7229

병 적 기 록 표

1. 구분 [redacted] 2. 징집년도 3. 혈액형 4. 면허 및 자격증 5. 출신기번 6. 일련번호

7. 본인 성명 한글 한자 [redacted] 본적 [redacted] 본직 생년월일 주소 (연필)

8. 학력 대학 과 년 재퇴졸 대학원 과 년 재퇴졸 고교 과 년 재퇴졸 국민교 년 퇴졸

9. 호주 또는 친권자 성명 [redacted] 주소 관계

10. 명수령인 성명 주소 관계

11. 직업 12. 경력

13. 가족관계 성명 생년월일 관계 직업

14. 외국어 정도 국명 영어 불어 독어 중국어 기타( ) 회화 번역

15. 상벌 16. 사상

17. 재산정도 동산 부동산 18. 종교 재산세 등급

19. 최기경찰서 최기우체국

20. 취미 21. 기호 22. 특기

23. 위 각항의 기재사항을 확인하여 그 내용에 허위의 사실이 없음. 66 년 10 월 10 일 작성 [redacted]

24. 징병처분사항 병종 선경 가경 징집순서 (군) 징병관 (함)

25. 인사분류검사 검사구분 검사종류 점수 등급

26. 신체검사 검사구분 검사년월일 검사장소 신장 흉위 체중 혈압 시력(좌)(우) 색맹 청력(좌)(우) X선 관절 치아 신체사항 징집등급 군징병관

27. 비고 [redacted]

육군인쇄공창

Figure 2.2
Sample Table Used for Inputting Data: Part of the *1969 Seoul Statistical Yearbook*

63. 두 류 수 확 고

단위 : { 면적…산보, 단수…kg, 수량…M/T

항 목	총계 Grand total			대두 Bay bean			소두 Red bean			녹두 Grean bean		
	면적 Area	단수 Production per dan	수확량 Produc-tion	면 면 Area	단수 Production per dan	수확량 Produc-tion	면적 Area	단수 Production per dan	수확량 Produc-tion	면적 Area	단수 Productiou per dan	수확량 Produc-tion
1 9 6 5	7 291	75	543.2	4 816	83	402.0	826	63	61.8	169	48	8.1
1 9 6 6	4 658	73	340.2	3 379	77	260.8	443	61	27.1	138	53	7.3
1 9 6 7	3 610	74	263.7	2 934	79	225.9	374	58	21.8	83	54	4.6
1 9 6 8	2 883	68	196.3	2 471	70	166.0	292	62	18.2	71	52	3.7
1 9 6 9	**2 700**	**75**	**202.6**	**2 112**	**80**	**167.9**	**349**	**64**	**22.2**	**101**	**56**	**5.7**
종 로	—	—	—	—	—	—	—	—	—	—	—	—
중 구	—	—	—	—	—	—	—	—	—	—	—	—
동 대 문	56	70	3.9	41	69	2.9	14	67	0.9	—	—	—
성 동	954	70	67.7	691	74	51.2	179	65	11.7	36	59	2.1
성 북	31	72	2.2	25	75	1.8	3	58	0.2	3	54	0.2
서 대 문	72	48	3.4	9	115	1.0	3	130	0.4	2	130	0.3
마 포	—	—	—	—	—	—	—	—	—	—	—	—
용 산	—	—	—	—	—	—	—	—	—	—	—	—
영 등 포	1 587	79	125.4	1 346	82	111.0	150	60	9.0	60	52	3.1

자료 : 산업국 농정과

64. 잡 곡 수 확 고 (정곡)

단위 : { 면적…단보, 단수 : kg, 수량…M/T

항 목	총계 Grand total			조 Millet			수수 Sorghuom			옥
	면적	단수 Production per dan	수확량 Production	면적 Area	단수 Production per dan	수확량 Production	면적 Area	단수 Production per dan	수확량 Production	면적 Area
1 9 6 5	2 273	78	176.9	996	86	86.0	438	84	36.7	206
1 9 6 6	1 334	69	91.4	502	70	34.9	469	73	34.1	141
1 9 6 7	699	81	56.6	178	83	41.7	267	92	24.5	117
1 9 6 8	564	68	38.1	167	64	10.7	176	72	12.7	105
1 9 6 9	**523**	**69**	**36.1**	**75**	**74**	**5.5**	**242**	**68**	**16.5**	**144**
종 로	—	—	—	—	—	—	—	—	—	—
중 구	—	—	—	—	—	—	—	—	—	—
동 대 문	18	85	1.5	1	100	0.1	—	—	—	17
성 동	228	72	16.4	43	83	3.5	72	73	5.3	57
성 북	21	66	1.4	—	—	—	3	59	0.2	18
서 대 문	57	85	4.9	10	78	0.8	38	100	3.8	6
마 포	—	—	—	—	—	—	—	—	—	—
용 산	—	—	—	—	—	—	—	—	—	—
영 등 포	199	60	11.9	21	53	1.1	129	56	7.2	46

자료 : 산업국 농정과

Figure 3.1
Height at Conscription: Comparison of Different Samples

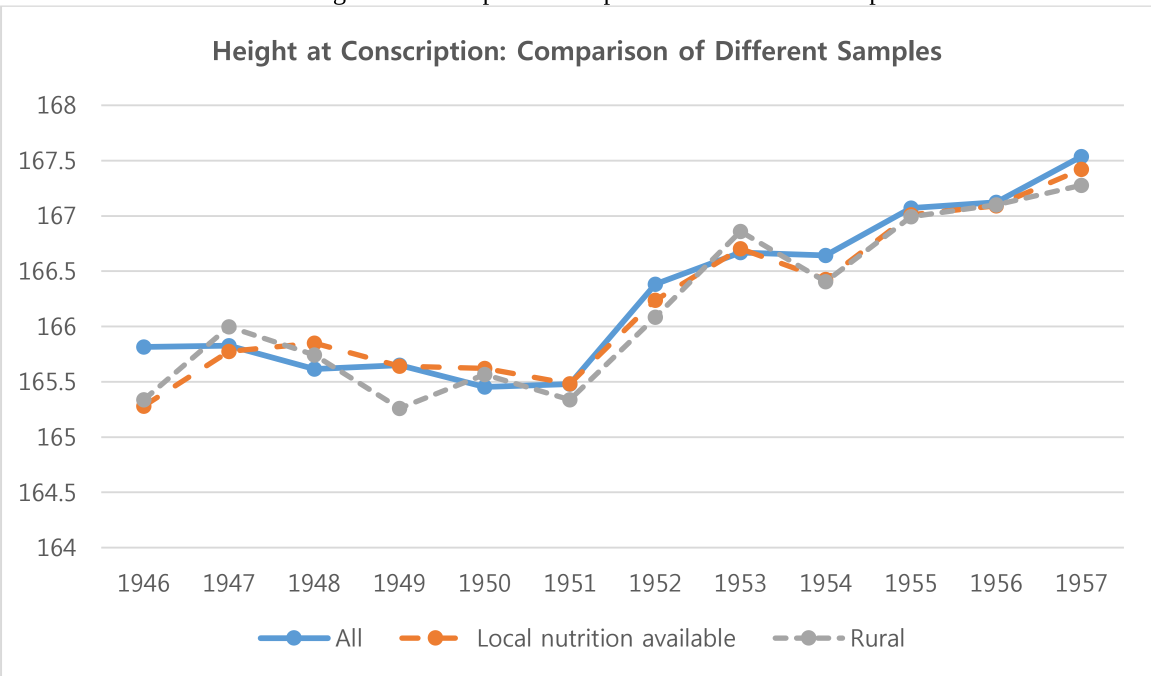
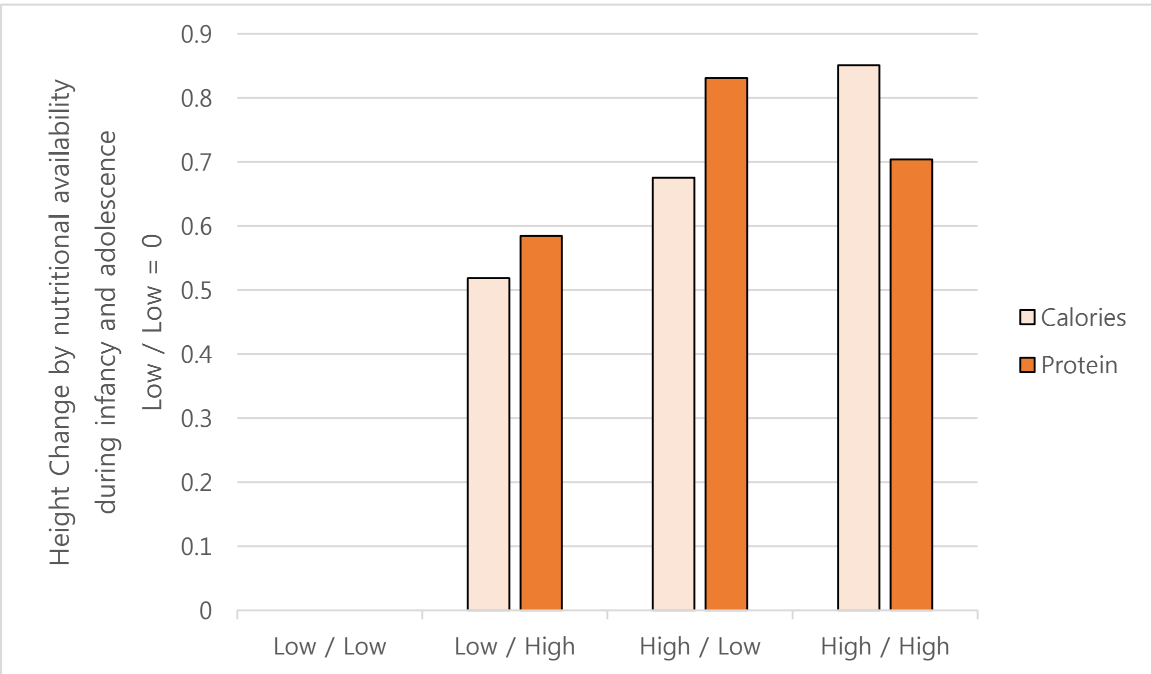


Figure 4.1
Local Nutritional Availability during Infancy and Adolescence and Height Change (Cm)



Appendix

Appendix Table A.1
List of Data Sources Used in Construction of Dataset

Data Sources	Publication Year	Form
The *Korea Statistical Yearbook*	1952~1954 1957~1978	Pdf files
The *Food, Agriculture, Forestry and Fisheries Statistical Yearbook*	1955~1978	Pdf files
The *Seoul Statistical Yearbook*	1948~1950, 1952~1956, 1958~1978	1948, 1950, 1952~1956, 1958~1959: jpg files capturing some pages of books at the National Assembly Library 1949: an e-book from the website of the National Assembly Library. The rest: pdf files
The *Busan Statistical Yearbook*	1962~1978	1964, 1967: e-books from the National Archives of Korea 1973: e-book from the National Assembly Library The rest: e-books from the Busan Metropolitan City
The *Gyeonggi Statistical Yearbook*	1954~1955 1960~1965 1967~1978	1954~1955, 1960: e-books from the National Assembly Library The rest: pdf files
Statistical yearbooks of counties under the control of Gyeonggi Province	1966	Gapyeong, Suwon, Siheung, Anseong, Incheon, Paju, Pyeongtaek, Hwaseong: pdf files Ganghwa, Goyang, Gwangju, Gimpo, Bucheon, Yangju, Yangpyeong, Yeoju, Yeoncheon, Yongin, Uijeongbu, Icheon, Pocheon: jpg files capturing some pages of books from Statistics Korea Library
The *Gangwon Statistical Yearbook*	1958 1961~1965 1967~1978	1958: a pdf file The rest: e-books from the Gangwon Province
Statistical yearbooks of counties under the control of Gangwon Province	1966	Gangneung: an e-book from the National Assembly Library Goseong, Sokcho, Jeongseon, Cheorwon, Chunseong, Chuncheon: jpg files capturing some pages of books from Statistics Korea Library
The *Chungbuk Statistical Yearbook*	1961~1965 1967~1978	1961, 1963, 1968~1969: jpg files capturing some pages of books from the Statistics Korea Library The rest: e-books from the National Archives of Korea
Statistical yearbooks of Counties under the control of Chungbuk Province	1966	Goesan, Danyang, Boeun, Yeongdong, Okcheon, Eumseong, Jecheon, Jungwon, Jincheon, Cheongwon, Cheongju, Chungju: jpg files capturing some pages of books from Statistics Korea Library
The *Chungnam Statistical Yearbook*	1955~1958 1960~1965 1967~1978	Pdf files
Statistical yearbooks of counties under the control of Chungnam Province	1966	Gongju, Geumsan, Nonsan, Daejeon, Seosan: jpg files capturing pages of books from Statistics Korea Library
The *Jeonbuk Statistical Yearbook*	1957~1958 1960 1962~1965 1967~1978	1957~1958, 1960: e-books from the National Assembly Library 1962~1965, 1967: e-books from the National Archives of Korea The rest: pdf files
Statistical yearbooks of counties under the control of Jeonbuk Province	1966	Gunsan, Gimje, Namwon, Muju, Buan, Okgu, Wanju, Iri, Iksan, Imsil, Jangsu, Jeongeup, Jinan: jpg files capturing some pages of books from the Statistics Korea Library Sunchang, Jeonju: e-books from the National Assembly Library

Data Sources	Publication Year	Form
The *Jeonnam Statistical Yearbook*	1954~1955 1959 1963 1965 1967~1978	1954~1955, 1959: jpg files capturing pages of books from the National Assembly Library 1963: jpg files capturing some pages of books from the Suwon Library of Seoul National University 1965, 1967~1968: jpg files capturing pages of books from the Statistics Korea Library The rest: e-books from the National Archives of Korea
Statistical yearbooks of counties under the control of Jeonnam Province	1961	Mokpo: jpg files capturing pages of books from the Statistics Korea Library
	1964	Muan, Yeocheon, Yeonggwang, Jangheung: jpg files capturing pages of books from the Statistics Korea Library
	1966	Gwangsan, Gwangyang, Damyang, Muan, Suncheon, Yeocheon, Yeonggwang, Wando, Janheung, Jindo, Hampyeong, Haenam: jpg files capturing pages of books from the Statistics Korea Library
The *Gyeongbuk Statistical Yearbook*	1963~1965 1967~1978	1963, 1964: jpg files capturing pages of books from the Statistics Korea Library 1967: a pdf file. The rest: e-books in homepage of the National Archives of Korea
Statistical yearbooks of counties under the control of Gyeongbuk Province	1960	Pohang: jpg files capturing pages of books from the Statistics Korea Library
	1961	Daegu: jpg files capturing pages of books from the National Assembly Library Pohang: jpg files capturing pages of books from the Statistics Korea Library
	1962	Gyeongsan, Yeongju, Pohang: jpg files capturing pages of books from the Statistics Korea Library
	1966	Gyeongsan, Goryeong, Gunwi, Gimcheon, Dalseong, Bonghwa, Seongju, Andong, Yeongyang, Yeongil, Yeongju, Ulleung, Wolseong, Cheongsong: jpg files capturing pages of books from the Statistics Korea Library
The *Gyeongnam Statistical Yearbook*	1961 1963~1965 1967~1978	1963: jpg files capturing pages of books from the Suwon Library of Seoul National University The rest: e-books from the National Archives of Korea
Statistical yearbooks of counties under the control of Gyeongnam Province	1958	Masan: an e-book from the National Assembly Library
	1966	Geoje, Geochang, Namhae, Sacheon, Sancheong, UIsan, Changnyeong, Changwon, Chungmu, Hadong, Haman: jpg files capturing pages of books from the Statistics Korea Library
The *Jeju Statistical Yearbook*	1961~1965 1967~1978	1961, 1963: jpg files capturing pages of books from the Statistics Korea Library 1962: jpg files capturing pages of books from the Suwon Library of Seoul National University The rest: e-books from the National Archives of Korea
Statistical yearbooks of counties under the control of Jeju Province	1966	Namjeju, Bukjeju, Jejusi: jpg files capturing pages of books from the Statistics Korea Library
Others		The *Statistical Path of Gangwon* (1993), the *50 Years of Wonju in the Sight of statistics* (2005), the *Statistical Path of Chungbuk* (1996), the *50 Years of Daejeon in the sight of Statistics* (1999): jpg files capturing pages of books from the Statistics Korea Library

Appendix Table A.2
Information in Statistical Yearbooks Related to Land, Population, and Agriculture

Category	Contents
Land area	Location Land area by county Land area by land type Land area by land owner (public/ private)
Population	Growth of population House and population by county Population by sex Population by age and sex Population by education level Population by occupation Registered foreigner Movement of population
Agriculture	Number of farm house and farm population Food grain production: rice, barley and wheat, miscellaneous grains, pulse, potatoes, vegetables, fruits, special crops, medicinal plants, tobacco Farm environment: agricultural machines, chemicals, fertilizers Farm disaster Agricultural economy policy: agricultural cooperative federation, farmland improvements, New Community (*Saemaul*) Movement, government purchase of food grains Livestock things: number of livestock heads by animal type, livestock slaughtered, infectious disease of livestock, veterinarians, improvements of livestock environment

Table A.3
Variables Inputted into Dataset on Agricultural Output and Nutritional Availability

Category	Contents	Unit
Year	Survey year	
Region	Entire nation, names of provinces and counties	
Land area	Land area by year and locality	m^2
Population	Total, male, female population by year and region Population by age interval and sex for each year and region	
Agriculture: Food grains	Farm population by year and region	
	Farm house by type of management of farm land for each year and region: Paddy field, upland (dry field), fruits, vegetables, special crops, slash-and-burn field, livestock, sericulture, bee-raising, horticulture, wage earner	
	Rice: cultivated area and output by year and region	m^2 and kg, respectively
	Barley and wheat: cultivated area and output by year and region - Barley, naked barley, wheat, rye	〃
	Miscellaneous grains: cultivated area and output by year and region - Foxtail millet (*jo*), barnyard millet (*Pi*), common millet (*Gijang*), sorghum (*susu*), corn, buck wheat (*memil*), oatmeal	〃
	Pulse: cultivated area and output by year and region - Soy bean, red bean, green been, kidney bean, pea, peanut	〃
	Potato and sweet potato: cultivated area and output by year and region	〃
	Vegetables: cultivated area and output by year and region - Radish, Chinese cabbage (*Baechu*), cabbage (*Yangbaechu*), sweet melon (*Chamoi*), cucumber, eggplant (*Gaji*), pumpkin, watermelon, tomato, red pepper (*Gochu*), welsh onion (*Pa*), garlic, spinach, onion, taro (*Toran*), water parsley (*Minari*), burdock (*Ueong*), carrot, ginger, strawberry, asparagus, lettuce (*Sangchu*), head lettuce (*Gyeolgusangchu*), crown daisy (*Ssukgak*), salary, Chinese leek (*Buchu*), cabbage lettuce (*Yangsangchu*), lotus root, pepper (*Pimang*), parsley, greenhouse melon, outdoor melon, seasoned cabbage (*Bomdong*), rakkyo, haruna, Chinese yam (*Ma*), curled mallow (*Auk*), beet greens (*Geundae*), bellflower root (*Doraji*), bourd (*Bak*)	〃
	Fruits: cultivated area and output by year and region - Apple, pear (*Bae*), Persimmon (*Gam*), grape, peach, plum (*Jadu*), apricot (*Salgu*), mandarin, pineapple, Korean cherry (*Aengdu*), cherry, Japanese apricot (*Maesil*), chestnut (*Bam*), jujube (*Daechu*), yuja, Japanese persimmon (*Dangam*), loquat (*Bipa*), quince (*Mogwa*), fig (*Muhwagwa*), pomegranate (*Seokryu*)	〃
Agriculture: livestock	Livestock breeding - Cattle, milk cow, beef cattle, horse, pig, goat, rabbit, chicken, duck, goose, dog, turkey, bee, sheep, deer, pheasant, hawk (*Mae*), donkey, mule	Unit (Bee: box)
	Livestock slaughtering - Cow, pig, chicken, horse, goat, dog, rabbit	Unit, kg

Note. Outputs of rice, barley and wheat, miscellaneous grains, pulse, potato, sweet potato were all weighed as polished grains.

Appendix Table A.4

Calorie and Nutrition Ingredient per 100g of Each Food in Agricultural Output and Nutritional Availability Dataset

Food	Detailed	Calorie (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Kalium (mg)	Natrium (mg)	Vitamin A (RE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B3 (Niacin) (mg)	Vitamin C (mg)
Rice	White rice	363	79.5	6.4	0.4	7	87	1.3	170	8	1	0.23	0.02	1.2	0
Barley		352	78	10	1	24	129	1.7	270	18	0	0.27	0.07	1.4	0
Naked barley		347	77.7	9.9	0.6	19	72	1.4	270	5	0	0.41	0.04	0.9	0
Wheat		333	75.8	10.6	1	52	254	4.7	538	17	0	0.43	0.12	2.4	0
Rye	Whole rye	334	70.7	15.9	1.5	10	378	6.4	501	2	0	0.26	0.16	1.8	0
Foxtain millet	Nonglutinous millet	386	76	9.7	4.2	11	184	2.3	368	3	0	0.21	0.09	1.5	0
Barnyard millet		367	72.4	9.7	3.7	7	280	1.6	240	3	0	0.05	0.03	2	0
Common millet		357	74.6	11.2	1.4	14	226	2.8	233	6	0	0.42	0.09	2	0
Sorghum		364	74.1	9.5	2.6	14	290	2.4	410	2	0	0.1	0.03	3	0
Corn	Glutinous corn	142	29.4	4.9	1.2	21	131	2.2	370	1	9	0.25	0.11	2.6	0
Buck wheat		374	74.7	11.5	2.3	18	308	2.6	477	14	17	0.46	0.26	1.2	0
Soy bean		420	30.7	36.2	17.8	245	620	6.5	1340	2	0	0.53	0.28	2.2	0
Red bean		356	68.4	19.3	0.1	82	424	5.6	1180	1	0	0.54	0.14	3.3	0
Green bean		354	62	22.3	1.5	100	335	5.5	1323	2	12	0.4	0.14	2	0
Kidney bean		169	29.2	10	1.2	62	97	3.7	732	5	0	0.48	0.11	1.6	4
Pea		79	13.2	5.8	0.3	25	134	1.6	356	13	1	0.01	0.09	0.8	12
Peanut		568	26	24.5	45.1	68	409	6.7	898	7	5	0.4	0.1	3	6
Potato		63	13.9	2.4	0	14	117	4.2	556	21	1	0.26	0.04	0.4	8
Sweet potato		131	31.2	1.4	0.2	24	54	0.5	429	15	19	0.06	0.05	0.7	25
radish	*Joseon* radish, root	21	4.6	1	0.1	26	38	2.3	257	43	0	0.11	0.03	0.5	15
Chinese cabbage		12	2.7	1.1	0	29	18	0.5	222	15	1	0.2	0.03	0.4	10
Cabbage		20	4.4	1.4	0.1	31	29	0.5	206	16	24	0.07	0.01	0.4	9
Sweet melon		38	7.5	2.2	0.4	6	79	0.3	663	10	6	0.07	0.03	0.6	21
Cucumber	Native	11	2.3	0.8	0.1	26	33	0.2	162	5	30	0.03	0.03	0.2	10
Eggplant		17	4	0.8	0.1	18	24	0.2	189	0	63	0.18	0.03	0.4	2
Pumpkin	Green pumpkin	26	5.6	0.9	0.1	30	36	0.4	215	17	34	0.16	0.02	0.4	9
Watermelon		32	8.1	0.8	0	5	14	0.5	169	1	31	0.06	0.01	0.3	0
Tomato		18	4.5	0.8	0	6	12	0.5	196	16	12	0.04	0.01	0.5	12
Red pepper	Dried	300	50.6	11	11	58	230	6.8	2930	56	4623	0.3	1.1	12.5	26
Welsh onion		29	6.7	1.2	0.2	25	26	1	239	17	1	0.02	0.04	0.3	11

Food	Detailed	Calorie (kcal)	Carbohydrate (g)	Protein (g)	Fat (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Kalium (mg)	Natrium (mg)	Vitamin A (RE)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin B3 (Niacin) (mg)	Vitamin C (mg)
Garlic	Green garlic	40	7.6	2.7	0.2	48	79	11	435	30	21	0.3	0.11	0.5	48
Spinach		33	6	3.1	0.5	40	29	2.6	502	54	479	0.12	0.34	0.5	60
Onion		36	8.4	1	0.1	16	30	0.4	144	2	0	0.04	0.01	0.1	8
Carrot		37	8.6	1.1	0.1	40	38	0.7	395	30	1270	0.06	0.05	0.8	8
Apple	*Busa*	49	13.1	0.2	0.1	6	9	0.3	146	16	1	0.05	0.03	0.5	48
Pear	*Singo*	41	10.9	0.3	0.1	2	11	0.2	171	3	0	0.02	0.01	0.1	4
Persimmon	*Daebong*	70	18.9	0.6	0	18	23	3.6	214	2	40	0.06	0.07	0.5	18
Grape	Campbell early	46	12.2	0.5	0.1	5	13	0.2	165	0	2	0.06	0.01	0.2	0
Peach	White peach	36	9.1	0.6	0.1	5	19	0.1	190	2	0	0.03	0.02	0.7	0
Mandarin	Native	39	9.9	0.7	0.1	13	11	0	173	11	1	0.13	0.04	0.4	44
Beef	Native, lean meat, uncooked	190	0.6	19.3	11.3	14	154	3.6	277	259	4	0.06	0.21	4.1	0
Pork	Lean meat, uncooked	241	0.4	17.8	17.5	5	179	2.1	51	17	4	0.78	0.19	4.5	0

Source: The 8th Revision of the Standard Food Composition Table (Published in 2013)